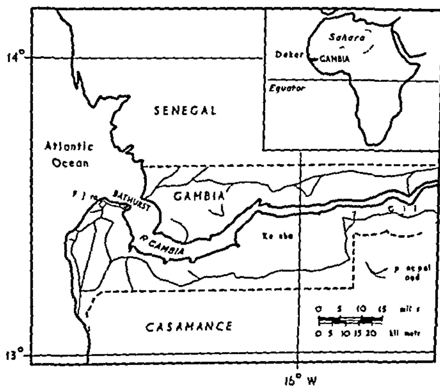


Gambian village women pounding coos i e the staple grain usually bulrush millet (*pennisetum* spp.) into meal or flour



COLONIAL OFFICE

Malnutrition in African Mothers, Infants and Young Children

REPORT OF THE

SECOND INTER-AFRICAN CONFERENCE ON NUTRITION

HELD UNDER THE AUSPICES OF

THE COMMISSION FOR TECHNICAL CO-OPERATION

IN AFRICA SOUTH OF THE SAHARA (C.C.T.A.)

AT FAJARA, GAMBIA

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MALNUTRITION IN AFRICAN MOTHERS, INFANTS AND YOUNG CHILDREN

INTRODUCTION

by the President, Professor B S. Platt

This Report of the Second Inter-African Conference on Nutrition held in 1952 under the auspices of the Commission for Technical Co-operation in Africa South of the Sahara (CCTA) at the Medical Research Council's Field Research Station, Fajara, Gambia, is based on papers circulated during the Conference These were prepared, with the co-operation of the contributors, by the General Secretary, Mr G Foggon, the Technical Secretaries, Dr O Lindan and Dr Rosemary Lindan, and with the help of staff kindly provided by the World Health Organization and of clerical staff recruited from Gambia residents All these papers have, however, been revised or re-written for publication Miss M. W Grant has assisted with the editing of the papers on dietetics, other members of the staff of the Applied Nutrition Unit, Miss C Vernon-Smith and Mr H Garling, who has drawn the diagrams, have contributed much time and effort, especially in many of the laborious details of preparation of the Report Miss J Fenning, secretary to the Human Nutrition Research Unit, has scrutinized the draft text and assisted with the proof reading. Many individuals not mentioned by name have contributed to the success of the Conference and thereby in some measure to the Report One of the recommendations at the First Inter-African Conference on Nutrition[5] held in 1949 at Dschang in the French Cameroons was that there should be a further Conference with a limited and well-defined agenda My suggestion that the Second Conference should be concerned with malnutrition in African mothers, infants and young children was accepted, and this Report deals with the clinical, pathological, biochemical, dietetic and therapeutic aspects of this subject

Included in the section on treatment is a preliminary consideration of a problem of paramount importance - the measures which will have to be adopted to prevent malnutrition, particularly in the vulnerable groups under review This problem is complex and its solution requires a grasp of many subjects Experience of the application of knowledge about the prevention of malnutrition in rural African communities is so meagre that it would have been premature to have done more than broach the subject, even if the membership of the Conference had been sufficiently representative of all the branches of knowledge concerned to be competent to consider it, this however, might well be the subject of a Third Nutrition Conference*

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* See Recommendation 7 page 365

Although the scope of the Second Conference was narrower than that of its predecessor, the nature of the material presented was, nevertheless, diverse in character   Parts of the Report - some of the demonstrations, for example - may seem to be somewhat irrelevant to the main theme of the Conference   However, the presentation of these items and the informal discussions about them which cannot be included in this Report did, at the time, link them as integral parts of the proceedings   Similarly, readers unfamiliar with conditions in Africa cannot, unfortunately, be introduced to the villagers and their homes, as was possible in the case of several guests at the Conference visiting Africa for the first time   It would be useful to read this Report in conjunction with the Report of the Third Session of the Joint FAO/WHO Expert Committee on Nutrition[19] which presents the problem of malnutrition in mothers, infants and children* as it is seen in the world generally   This Third Session was held at Fajara and immediately followed the CCTA Conference, four members of which served on the Joint Committee, the remaining delegates being invited to be present as observers   At the invitation of Her Majesty's Government those members of the Joint Committee who were not delegates to the CCTA Conference attended as observers

The Conference procedure was somewhat informal   the offices were for the most part allocated only after the Conference had opened, and formal contributions by President and Chairmen were not presented   The Chairmen summarized the proceedings of the session but, by agreement, these summaries have not been included in the Report except when Chairmen, in making their summaries, contributed to the discussion   This Introduction is in the nature of a Presidential address, it includes statements made at the opening and closing sessions of the Conference, and a summary of a document on the history of the Field Research Station and its place in the Central Nutrition Organization for Colonial Territories

The Field Research Station∮, at which the Conference was held, is at Fajara, near Cape St Mary, about ten miles from Bathurst Since the end of 1947 it has been built up, equipped and serviced out of a vote made available under the Colonial Development and Welfare Act   The original purpose of the Station was 'to provide facilities for research dealing with those problems of human nutrition and food technology which, for various reasons, could only be made, or could most conveniently be made, in a Colonial Territory' The work on the Station is part of a larger scheme which originated from proposals made in 1937 by a Research Sub-committee of the Committee on Nutrition in the Colonial Empire, under the Chairmanship of Sir Edward Mellanby   The pattern of the organization for the co-ordination of investigations into nutritional problems in

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* In 1953 there were three more Conferences partly or wholly concerned with the problem of malnutrition in mothers, infants and children

S E Asia Regional FAO/WHO Nutrition Committee Bandung Indonesia
Third Latin American Nutrition Conference of FAO/WHO Caracas Venezuela.
A symposium on Protein Malnutrition held in Jamaica

∮ Renamed in 1953 'Medical Research Council Laboratories'

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Colonial Territories, as it has evolved in the past few years, has been outlined in a leading article* in the British Medical Journal[1] With the formation of an *Applied Nutrition Unit* at the London School of Hygiene and Tropical Medicine the plan of the Central Nutrition Organization for Colonial Territories has been completed The main functions of the new Unit are

(1) to study and to exchange information on colonial nutrition and food technology,
(2) to provide advice and assistance in field work and investigations, and
(3) to assist in arrangements for training colonial personnel in nutrition work.

The work of this Unit is closely linked with that of the Medical Research Council's *Human Nutrition Research Unit* in London, and with the Field Research Station in the Gambia Recently the CCTA authorities have agreedø that an arrangement similar to that developed in the Applied Nutrition Unit for British Colonial Territories might be made by member governments of CCTA, and that each member government should have a representative responsible for exchange of information in the field of nutrition and the closely related fields of agricultural and community development

From 1947-50 the *Nutrition Field Working Party*, set up as an activity of the Central Organization for Co-ordination of Nutrition Investigations in Colonial Territories, worked in the Gambia An attempt was made to find out how to apply our present knowledge of nutrition to improve the health and well-being of a rural African community - it was what I have sometimes called 'an experiment or research in development' It has been described briefly and progress reported[12,13,14] (see also page 342) - I quote from one of these reports[12] a paragraph which may serve as a background to the problem still confronting us

> 'Whilst members of societies as highly developed as our own have derived immense benefits from the results of the work of scientists, the majority of the peoples of the world, particularly those in tropical countries and including most of the sixty-six million people in colonial territories, have for the most part benefited to only a small extent Indeed the results of "progress" have sometimes been detrimental to their health and well-being However, in spite of many successes in the application of scientific knowledge to the improvement

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* References are made in this leader to reports of the Medical Research Council's Human Nutrition Research Unit in London, reports of the work at the Station which form part of the reports of the Colonial Medical Research Committee and reports on the work of the Department of Human Nutrition at the London School of Hygiene and Tropical Medicine

ø See Recommendation XIV, 1st Nutrition Conference 1949[5] and Recommendation 4, 2nd Nutrition Conference 1952 (page 364)

'of conditions of life in modern communities, many difficulties in making innovations are experienced The prejudices against nutritious bread, the failure to secure satisfactory production marketing and household preparations of vegetables and the unappetising meals commonly served by large scale catering establishments all illustrate the difficulties encountered in improving the feeding of people in highly developed communities These are, however, trivial problems in comparison with those involved in work on the improvement of the nutrition of people in poorly developed communities The problems differ in kind as well as in magnitude Ignorance of the nature and size of the problems often leads to attempts at innovations which, in relation to the needs of the people, are pathetic and ludicrous It is not sufficiently appreciated that many of the techniques employed amongst literate people with a heritage of experience of various tools, appliances and machines, cannot readily be applied to the improvement of the standard of living of the population of backward countries, where illiteracy is almost universal and few individuals have any knowledge of the properties of metals, of such elementary mechanical practices as the use of simple levers or, as until recently in the greater part of Africa, of the existence of the wheel The solution of the problem of shortages of food applicable to better organised countries - the transference of surpluses - is impracticable for the majority of the peoples of the world, owing to the absence or inadequacy of the organisation, power or facilities to obtain, transport and distribute large quantities of foodstuffs The improvement of the nutrition of backward peoples must therefore begin with the people themselves and with the development of their immediate resources '

Attitudes and aptitudes

There is sympathy now with the view that small scale village work is basically important Responsible villagers usually support efforts to improve their opportunities for remunerative work in agriculture, they do not wish their young men and women to leave home in search of employment There is, on the other hand, no doubt that the problem of urbanization in Africa is intensified by the number of disillusioned Dick Whittingtons in the towns Agriculture must be recognized as being a major industry in Africa, and the conditions of living and working should be at least as good as in other industrial occupations

The Conference made a formal recommendation* that 'restorative measures should start at the family level within the village or small community' This point was further developed at the Meeting of the Joint FAO/WHO Expert Committee on Nutrition which agreed to include in the Report[19] of the Committee the following paragraph.

* Recommendation 3 (page 384)

'At every stage of an operation of this nature it is of the utmost importance that the attitude of the technical staff should be one of unselfishness and helpfulness and not one of authoritarianism and superiority . technical experts trained in one particular culture and undertaking work in an area unfamiliar to them, must adjust themselves to the culture prevailing in that area if the advice they give is to be realistic and their efforts are to meet with success '

The need for a sympathetic understanding of the attitude of the villager is now better appreciated, and it is rapidly being realized that technical authorities must be well-informed about conditions in the villages in which they work

One is often brought face to face with illuminating examples of the African's attitude, his shrewdness, insight, wisdom, and penetrating judgment, but these are only fully and spontaneously expressed when he feels at home with his fellow white man One anecdote must suffice Last year we were making a survey in a Gambian village (the one in which, as described later (page 22), the 'roped motor car incident' occurred) where we received, from the oldest villager downwards, a whole-hearted co-operation that would be difficult to equal in villages in many other parts of the world Having had experience of the courtesies, at the end of our visit I had presented salt, sugar and cigarettes, together with our thanks for their help and co-operation, to the villagers assembled outside the mosque Accepting these tokens of our appreciation, the village headman speaking for his village, said that he had been glad to help and thanked us for the gifts, adding, to my delight and to the amazement of some of my colleagues who were making their first visit to a remote African village, 'We are glad to see that the European is beginning to imitate the ways of the African by taking presents when he visits his friends'

The ideas of the 'foreigner' about the attitude of the African are often incorrect and may, on examination, have the most apocryphal foundations One chain of incidents will illustrate this point I recollect that in 1938 when I went first to East Africa I was given, as a local example of the African's failure to appreciate the benefits of modern technology, an account of an incident in which an African had been given a wheelbarrow with which to move a load and, to the amazement of his master, he put the load in the wheelbarrow and carried away both on his head Shortly after hearing this I was reading an old (1891) Gold Coast Report[10] in which His Excellency the Governor, commenting on the fact that the native, although having small and hardy cattle suitable for draught work, did not use the 17 miles of carriage road leading from Accra wrote, 'Imitative as the natives undoubtedly are of Europeans with regard to many things yet they are extremely conservative with respect to long established customs, and I doubt whether they would easily fall in with the idea of vehicular traffic in preference to the custom of carrying loads on their heads It is a local tradition that once a wheelbarrow was delivered to a native for use so that he could trundle a load

'in it instead of carrying it on his head, thereby avoiding the superincumbent weight, and he was instructed accordingly, with the results that when observed it was seen that he had placed the load on the wheelbarrow and then put the latter on his head and was carrying it that way ' It is instructive to note in passing that at the same time as I was reading this report a strike of African lorry drivers was temporarily paralysing the economy of the Gold Coast Ten years later I found in a section on native co-operation in a report[7] on water resources, the statement that 'The African usually prefers to use his muscles rather than his brain, labour he understands and even enjoys in company, but the idea of saving labour by a little forethought or planning does not come naturally to him The best illustration of that is the story of the contractor who bought wheelbarrows for his labourers only to find they carried them on their head ' The 'sundowner' element in this story becomes even more apparent when we take its history into account, along with that related[17] in the story of 'Moby Dick', written just over a century ago In Chapter 13 headed 'Wheelbarrow', Queequeg, the harpooner from the Pacific Islands, relates his first experience with a wheelbarrow which the owners of his ship lent him to carry his heavy chest to his boarding house Queequeg, 'not to seem ignorant about the thing - though in truth he was entirely so, concerning the precise way in which to manage the barrow puts his chest upon it, lashes it fast, and then shoulders the barrow and marches up the wharf'

There are a number of 'morals' that might be drawn from these stories, apart from their value as 'coals in the bath' stories The 'factor of ignorance' which is clear in the 'Moby Dick' version no doubt underlies the African attitude to some of the methods and devices of modern technology The amazing thing is not that he does not understand, but that he understands as well as he does One basis for this understanding may be discovered in his reaction to an agricultural demonstration I remember well the scathing comments of the village farmers at Genieri when they saw the groundnut planter sowing seed 'How', they said, 'do you expect any self-respecting seed to grow after being put through a contraption of that kind?' However, their fairmindedness came uppermost a few days later when, to their undisguised amazement, they saw the green leaves of groundnut shoots, and their admiration was overwhelming when the crop was lifted so much so that their normal courteous salutations were temporarily replaced by 'How good are the groundnuts'' Here I would like to make what ought to be a most obvious point, though one very often overlooked, that new techniques have to be demonstrated and their merits made known to people before any interest in them can be expected or fostered When new techniques are feasible and acceptable, then the methods of using them must be taught - this most obvious condition is by no means always appreciated as is revealed in a report[18] on a recent investigation into the efficiency of African labour

The ignorance factor, we must admit, may not always be the African's ignorance for, as has been pointed out[4], 'The ignorance (and sometimes the prejudice) is not confined to those who are

themselves undernourished. It exists also among those who have power over nutrition of others, Government officials, members of Legislative Councils, employers of labour, education authorities, missionaries ! Thus, although it is true that amongst people of backward areas there is a high illiteracy rate and little or no contact with technological developments or their possible benefits, these areas are often also those in which there is lamentable ignorance on the part of technologist and others about soils, crops, systems of agriculture, pests and plant diseases and the like Much as we may take the African to task for his indifference or apathy towards our technology, we ourselves have the heavy responsibility of ensuring that the introduction of the new knowledge leads to improvement of health and well-being and does not, in fact, make matters worse I remarked during a discussion (page 98), and it is perhaps of sufficient importance to merit repetition, that protein malnutrition occurs in partly urbanized communities and may largely, though possibly not entirely, be an accompaniment of sophistication

In seeking to improve the scope of life we should therefore not forget to take into account the traditional attitudes and sociological factors We should try to evaluate them accurately by making careful observations of what is going on, and, in anything we do in building up the future, retain the elements that are worthwhile as a basis for a new social structure that will benefit the African himself We must discount some of the stories that are told and the interpretation put upon them by people who are not trained observers, who are not skilled in drawing conclusions from observations but who, nevertheless, may appear to be knowledgeable about the African

Extent and intensity of problems

Nowhere is it so clear as in the African village that there are few, if any, activities that are not in one way or another related to eating, procuring and distributing food, most villagers are directly concerned in food production and all, of course, in food consumption In order to ensure an adequate and balanced diet, food supplies must be related to the size and requirements of the population There is need for a balanced agriculture and a balanced economy, and all these balances must be struck together in a satisfactory social system effectively administered To achieve this there must be knowledge of many subjects, technical, political, social and economic, and work on improvements requires co-operation between experts, technicians and technologists and practitioners, as well as between these and the people to whom help is being given

Organization of these different interests in research and development, and the responsibility for the decision on their relative importance in development, are still unsolved problems which have engaged the attention of many, including the most eminent authorities[11] on Africa Various exponents of their subjects, including the mass educationalist, the anthropologist and the social geographer,

have laid claim to the right to direct and play a leading role in these matters

It is now recognized that communities depend for their existence, survival and advancement on their knowledge of themselves and the properties of things in the world around them Intense mental effort and clear vision are needed in making adjustments to changes in conditions, outlook and ideas These elements have probably been lacking in the Africa with which we are concerned - so much so that it has been called[20] 'the modern complication and mess', in the production of which it is supposed that 'never has so much money been spent and so much energy displayed by so many European nations with so little clear idea of why they were doing it' These pronouncements should be a warning to us not to emulate the man in one of Stephen Leacock's books who jumped on his horse, dug in his spurs and rode off in all directions It is, however, well to remind ourselves that, as H G Wells once pointed out, 'although since the days of Buddha and Confucius there have been very many noble and beautiful things said about freedom, truth and the equal brotherhood of man the practical liberation of the world mind began not with any of these great aspirations It began with the invention of paper, and of printing from movable type Invention and discovery are the true liberators '

There are few developments in modern technology so striking as those in transport and communication A century ago, the unit of society was the almost self-sufficing village Distances have been conquered and the world has in effect become a much smaller place - and it is the unit of society today A change of outlook and adjustments of our ways of living have become necessary Members of highly developed communities are still not in tune with their new obligations, how much greater must the problems of relations be between these and members of such communities as are found in the villages of Africa

The striking speed with which changes are occurring in the world has been the theme of many recent scientific discussions, and in his presidential address[21], 'The Passing World', given in 1948 to the British Association, the former chairman of the British Cabinet Scientific Advisory Committee drew on events in Africa to illustrate 'these hurrying years' He pointed out that only 76 years previously his predecessor, Dr William Carpenter, had said when referring to the return of the expedition sent to the relief of Dr Livingstone 'While we give a cordial welcome to Mr Stanley, let us glory in the prospect now opening that England and America will co-operate in that noble object - which far more than our discovery of the sources of the Nile - our great Traveller has set before himself as his true mission, the Extermination of the Slave Trade '

One of the Gambian villages in which we have been working was the scene of an incident which illustrates how rapidly changes are occurring A District Commissioner, who died only a few months

ago, was visiting the village in his car, and the villagers, who had never seen a motor car before, were terrified and, like the Lilliputians, fetched ropes and tied down the mechanical Gulliver to prevent it from escaping and doing damage to their homes and lands

Food supply and population

So far I have been dealing with factors in defining problems, and some which have been taken into account in arriving at solutions for them. I would like to give a brief and sobering glimpse of what seems to me to be an outstanding problem of the future, that is, the relationship of food supply to increasing population

We know that infant and child mortality rates are high and that they are at their highest, about 500 per thousand, when the population is affected by malnutrition and malaria In the village of Keneba the infant mortality rate was nearly 500 per thousand during the first year of the survey[9] A year after control measures against malaria had been instituted, there were 42 live births, one still birth and one miscarriage, and only one infant died However, the following year, in which malaria measures were continued, out of 37 live births there were 13 deaths In this year there was a particularly severe 'hungry season', and it is suggested that the very high infant mortality rate may be the result partly of malarial infections and partly of malnutrition It is of some interest that in a village known to be malarial but where there is a good and adequate food supply, two surveys at intervals of three years showed that infant mortality rates were 167 and 165 per thousand However, in a study over the last three or four years of a group of infants (333) who from birth were under the care of a competent, trained midwife, 69 have already died

If, then, antimalarial measures are successfully applied and food supplies are improved, substantial increases of population may be expected It is reasonable to suppose also that the expectation of life will be increased, again adding directly to the number of people to be fed It has been estimated that in India[8], with similar conditions life-saving and life-prolonging measures would approximately double the number of women living to a child-bearing age providing a further potential for population increase Urgent, then, as the problem seems to be at the present time, and difficult as it is to increase the quantity of food, how much greater will be the problem if more food of improved quality has to be obtained to feed the people when, as we know, the rate of increase of population is already outpacing the rate of increase of food supplies

Already the world population is increasing by tens of thousands a day - the rate of increase is advancing steadily - and nearly half the population of the world is not getting enough to eat

There is a 'cornucopian school' of agronomists and others who believe that the world's resources are capable of supporting, at a better standard of living, a bigger population The evidence is

not reassuring The amount of land estimated as suitable for agriculture is limited True, yields might be increased, new crop varieties giving high yields are being discovered - and there is plenty of room for improvement of agriculture, especially in tropical countries Also, foodstuffs might be synthesized in the factory, possibly with the help of solar energy But the demands are also increasing 'For three hundred years the rate of increase of people, and so of misery and hunger for the vast majority, has relentlessly accelerated Even if the acceleration were to stop, and the current increase of one per cent a year were to continue for only the better part of a century, numbers would have more than doubled in 25 years '[6]

A most encouraging sign is that in many of the countries in which overcrowding is a pressing problem, some people are beginning to take action to limit the growth of their populations For example, Puerto Rican women are submitting to sterilization, and in India[3] plans have been drawn up for a Ministry of Welfare which is to include not only a Bureau of Growth and Nutrition, but also a Bureau of Marriage

The attitude of people generally is the main obstacle to further actions - 'there does seem to afflict, even the most educated, a distaste amounting to wilful blindness even for the recognition of population dynamics and the inevitability of change optimal populations do not appear by magic, by waiting, or by unchecked reproduction, but can only emerge by taking thought and finally appropriate action '[2]

I have recently summarized my views on the importance of making maternity and child welfare work the starting point of a campaign against ill health in backward countries, in a report to the 5th International Congress of Tropical Medicine and Hygiene at Istanbul in August 1953 'Eradication of zymotic disease factors may be the easiest, cheapest and most effective first step in reducing the prevalence of protein malnutrition Morbidity, malnutrition, and ability to make the best use of natural resources are, however, so inter-related that it is hardly likely that any one measure can be applied without affecting others in the complex and, indeed, it is likely that in practice several related measures may be applied more or less simultaneously There are good reasons for selecting mothers and infants for special consideration in making plans for reducing protein malnutrition in an affected community By starting in the early stages of the infant's growth the hopes of producing a healthy human subject are greater than if attempts are made to improve the state of nutrition of an older already damaged body, possibly irreversibly injured The prevention of illness and the saving of the lives of infants are likely to appeal as objectives to the love and affection of parents, especially the mother Women and more especially those who are producing and rearing young, are, in many communities where protein malnutrition is prevalent, the main producers of food crops Biologically it is sound because with increased amounts of improved foods more

breast milk can be produced for the infant It is eminently justifiable to do this instead of trying to apply to backward communities measures which it has been difficult enough to introduce successfully elsewhere In countries where protein malnutrition is prevalent amongst infants, it is particularly important that the infant should be given human breast milk and that the baby should be nursed at the breast for two or more years as is commonly the custom amongst "unspoiled" peoples

'If infant lives are saved there will be more mouths to feed, if protein malnutrition is reduced, expectation of life will be increased, adding still more mouths The size of populations is likely to be still further increased as the number of females who live to bear children rises There is already a world need for increasing food supplies to meet the present requirements for satisfactory nutrition An immediate result of the raising of standards of nutrition will be a need for a further increase of food production It is recognised that the equilibrium between populations and food supplies has in civilised communities, been attained only when a comparatively high standard of living has been reached In order to attain this standard of living generally it will be necessary to outpace the expected increases of population by a many-fold increase of productivity, mainly of food and other agricultural products '

I would like to add to this statement the suggestion that the maternity and child welfare worker is in a strategically good, if not, indeed, in the best position to assist the mother to plan the size of her family to its ultimate advantage and advancement

'For every problem,' Sir Edward Mellanby[15] observes, 'the only solution is more knowledge and more wisdom to use this knowledge There is no limit to the amount of knowledge to be gained, if the medical scientist is given the opportunities and facilities for his work. Would that the same could be said about the wisdom necessary to make the best use of this knowledge ' Sir Edward[16] also comments, 'There can be but little doubt that most of the political, social and economic difficulties in tropical countries are, and will continue to be, biological in nature, and the sooner this fact is recognized the sooner will these difficulties be controlled or dispersed There are some people who recognize the difficulties of the future, and some of these look with disfavour at the extension of medical knowledge and its application to native people having put our hands to the plough, however, there can be no turning back, and we can only pray that there is sufficient wisdom left among us to use the fruits of science properly '

January, 1954

not reassuring The amount of land estimated as suitable for agriculture is limited True, yields might be increased, new crop varieties giving high yields are being discovered - and there is plenty of room for improvement of agriculture, especially in tropical countries Also, foodstuffs might be synthesized in the factory, possibly with the help of solar energy But the demands are also increasing 'For three hundred years the rate of increase of people, and so of misery and hunger for the vast majority, has relentlessly accelerated Even if the acceleration were to stop, and the current increase of one per cent a year were to continue for only the better part of a century, numbers would have more than doubled in 25 years '[6]

A most encouraging sign is that in many of the countries in which overcrowding is a pressing problem some people are beginning to take action to limit the growth of their populations For example, Puerto Rican women are submitting to sterilization, and in India[3] plans have been drawn up for a Ministry of Welfare which is to include not only a Bureau of Growth and Nutrition, but also a Bureau of Marriage

The attitude of people generally is the main obstacle to further actions - 'there does seem to afflict, even the most educated, a distaste amounting to wilful blindness even for the recognition of population dynamics and the inevitability of change optimal populations do not appear by magic, by waiting, or by unchecked reproduction, but can only emerge by taking thought and finally appropriate action '[2]

I have recently summarized my views on the importance of making maternity and child welfare work the starting point of a campaign against ill health in backward countries, in a report to the 5th International Congress of Tropical Medicine and Hygiene at Istanbul in August 1953 'Eradication of zymotic disease factors may be the easiest, cheapest and most effective first step in reducing the prevalence of protein malnutrition Morbidity, malnutrition, and ability to make the best use of natural resources are, however, so inter-related that it is hardly likely that any one measure can be applied without affecting others in the complex and, indeed, it is likely that in practice several related measures may be applied more or less simultaneously There are good reasons for selecting mothers and infants for special consideration in making plans for reducing protein malnutrition in an affected community By starting in the early stages of the infant's growth the hopes of producing a healthy human subject are greater than if attempts are made to improve the state of nutrition of an older already damaged body, possibly irreversibly injured The prevention of illness and the saving of the lives of infants are likely to appeal as objectives to the love and affection of parents, especially the mother Women, and more especially those who are producing and rearing young, are, in many communities where protein malnutrition is prevalent, the main producers of food crops Biologically it is sound because with increased amounts of improved foods more

INAUGURAL ADDRESS

by

His Excellency the Governor of the Gambia,
Sir Percy Wyn-Harris, K C M G , M B E

Today is an historic day in the Gambia as it is the first time that the territory has been chosen as the meeting place for an International Conference, and in bidding you welcome on behalf of the Government and the people of the Gambia I feel very conscious of the honour which this meeting of distinguished medical scientists is conferring on us It is also, of course, an acknowledgement of the value of the research on nutrition in Africa which the Medical Research Council is carrying out here, and I would pay tribute to Professor Platt who, as you know, is directing that research, and who has also been the moving spirit in the organization of this Conference In mentioning this work I could not let the occasion pass without referring also to those workers with Professor Platt who have been labouring on nutritional problems, often in the Protectorate under conditions of considerable personal discomfort All of us in the Gambia pride ourselves on being a friendly people and our welcome to you today is both warm and sincere, and we will do our best to make your stay among us as comfortable and as pleasant as our somewhat limited resources permit 'Limited' I use advisedly, for you will realize that this Conference has temporarily increased our total European population in the territory by nearly 25 per cent, and such an increase does rather strain our accommodation and even raises nutritional problems which I hope you will find we have solved

I am very much aware of the amount of expert knowledge on nutrition which is gathered in this Conference Room this morning, and I have no doubt that your deliberations on the important matters on your Agenda Paper will mark this Conference as a milestone in the study of the problem of nutrition in Africa As I am addressing a Conference of experts my remarks will be aimed at underlining the integral part your work must play in the general administration of a territory if permanent and real progress is to be achieved in Africa

Many of us who have been concerned in administration in Africa - particularly those of us who have worked in the field - have had to grapple with food shortages hunger and even famine, but not until comparatively recently has it been fully realized outside the medical field that once the more dramatic evidences of famine and hunger have been removed there remains an even more intractable problem - that of malnutrition - a problem somewhat different from hunger and undernutrition Indeed it would not be too much to say that the very success that has attended efforts to remove famine has contributed to and in some cases even created, problems of malnutrition For example I need only refer to cassava, which I see is to come under your deliberations at this Conference The introduction of cassava into Africa as a means of combating famine has been most efficacious in certain areas It has several great advantages it will grow in tired soils it is remarkably drought resistant and more important, it solves its own storage problem by remaining in the ground until it is dug up in times of stress Cassava has however certain nutritional deficiencies and, when used as the staple of a people, raises

REFERENCES

1 Anon (1951) *Brit med J*, ii, 33

2 Bertram, G C L (1951) *Eugen Rev*, 43, 11

3 Chandrasekhar, S (1950) *India's Population, Indian Institute for Population Studies, Chidambaram.*

4 Committee on Nutrition in the Colonial Empire (1939) *Cmd 6060, Part I, p 104, H M S O*

5 *Conférence interafricaine sur l'Alimentation et la Nutrition, Dschang, Cameroun, 1949 (1950) p 474, CCTA, Paris*

6 Cook, R C (1951) *Human Fertility, Gollancz, London*

7 Debenham, F (1948) *Colon Res Publ No 2 p 28, H M S O*

8 Forbes, W H (1952) *Fed Proc*, 11, 667

9 Gamble, D P (1952) *J trop Med (Hyg)*, 55, 146

10 *Gold Coast (1891) Colon Rep misc Ser, No 1, p 8, H M S O*

11 Hailey, Lord (1942) *Advanc Sci, Lond*, 2, 41

12 London School of Hygiene and Tropical Medicine *Report of the Work of the School for the year 1947–8, p 70*

13 London School of Hygiene and Tropical Medicine *Report of the Work of the School for the year 1948–9, p 38*

14 London School of Hygiene and Tropical Medicine *Report of the Work of the School for the year 1949–50, p 39*

15 Mellanby, E (1939) *Recent Advances in Medical Science a study of their social and economic implication, pp 59, 62, Cambridge University Press, London*

16 Mellanby, E (1939) *The State and Medical Research, p 40, Oliver & Boyd London*

17 Melville, H (1907) *Moby Dick, p 155, Dent London*

18 Northcott, C H (1949) *Colon Res Publ, No 3, H M S O*

19 *Report of the Joint FAO/WHO Expert Committee on Nutrition (Third Session) 1952 (1953) Wld Hlth Org techn Rep Ser, No 72*

20 Rennel of Rodd, Lord (1948) *Advanc Sci, Lond* 5, 205

21 Tizard, H (1948) *Advanc Sci, Lond*, 5, 155

with his fellows, is, after the desire for survival, possibly the main incentive which makes him work hard and cheerfully for the long periods necessary to give him his bare subsistence and other minimum social needs But once reach that subsistence level for himself and his family, and once attain the social necessities of his village life such as the acquisition of a wife, a house and the like, then a desire for long periods of leisure becomes, I suggest, a most powerful incentive backed as it is by the social sanction of centuries The point is well illustrated by the well known phenomenon in Africa of the 'target' worker who labours for a certain monetary goal and having achieved that goal leaves his occupation and returns home, another quite common case is that of the fisherman who if he gets double the price for his fish will catch half the usual quantity of fish, get the same return as before and then spend the time saved in what some outside observers would call idleness, and the African leisure It is a point of view difficult for Europeans conditioned to the speed of the modern world, to appreciate, but it would have been better understood by our own great-grandfathers

I appear to have wandered a long way from the subject of malnutrition, but I feel we must emphasize that while the removal of malnutrition from a people is a necessary requisite of permanent advance, any real improvement in nutrition must also go hand in hand with improvement in other fields, particularly education I use the term 'education' in its widest sense to include changes in methods of agriculture, social changes in the villages and an acceptance by African villagers that higher standards of living require greater output and longer hours of work. The task of nutritionists therefore must integrate with the work of the agriculturalist, the educationalist, the medical officer and the sociologist To sum up, nutrition must be a part of good government generally, if the progress which we are attempting to make in other fields of administration is to be fully effective

Having attempted to stress the importance of improvement of nutrition in Africa, I will now turn to the nature of the problem which you are tackling as it strikes a layman It has long been known to individual doctors and medical investigators that the extent of malnutrition as opposed to undernutrition or hunger is more widespread, and its effect on progress in Africa far more serious than was popularly believed I doubt, however, whether the problem was ever brought into sharp focus until the various governments and organizations which are represented by you Gentlemen here today undertook systematic research into nutritional problems This correlated research in Africa is fairly recent and even now it may still be considered to be in its early stages Even so, one of the immediate results of research is to bring increasing public attention to the problem In the past many medical officers working in Africa have noticed with growing concern isolated phenomena of malnutrition, such as the prevalence of rickets in African children of those tribes which have come to regard milk as a cash crop rather than as a food for children, while the more dramatic evidences of malnutrition, such as the dry crackled skins and pot-bellies of ill nourished children have been observed with feeling of helpless pity by all who have come

problems of malnutrition Unfortunately in some areas where land has become seriously impoverished cassava has ceased to be an auxiliary food and has become the staple Changes in diet however, are not only caused by *force majeure* but may be due to other reasons, such as a new crop's proving easier to cultivate or to reap, easier to process or cook, or being more palatable Observers have noted with concern some changes in diet from the traditional which may well be harmful For instance, traditionally, Kikuyu women in East Africa when pregnant ate one particular kind of millet which I have heard stated contained a comparatively high percentage of calcium With the introduction of maize meal that custom died out In traditional diets - particularly when hunger or famine is epidemic in the area - there is often a fair variety as the people eat wild fruits and vegetables which they do not do when a sufficient quantity of an acceptable staple is either grown or imported In some areas these so-called wild vegetables - for instance nettles - are actually cultivated and eaten as part of the normal diet The study of the dietetic value of the wild fruits and vegetables traditionally eaten might, I think, be a profitable field of investigation

It is interesting to record that about 18 months ago in this territory we became alarmed at the manner in which baboon and wild pig were solving their own nutritional problems by devastating the farms of the Protectorate, and as a result of a continuing and intensive campaign we have reduced their numbers by some 50,000 baboon and 25,000 wild pig This campaign, besides reducing the damage to cultivated farms for which we had hoped, has provided an interesting human nutritional by-product in that several districts have reported with approbation that this season there is a large harvest of traditional forest fruit and vegetables which would otherwise have been eaten or destroyed by baboon

Speaking as an administrator it is not altogether clear to what extent progress is retarded in African rural areas by malnutrition and how much can be attributed to lack of incentive and other social causes I myself think it is impossible to dissect the effect of malnutrition from the other causes of retarded progress in a particular people, but it is certain that where serious undernutrition or malnutrition is widespread, then education, the application of other techniques or even important incentives - such as the increase of money income - cannot alone sustain permanently a people above the bare subsistence level Therefore a reasonable nutritional standard is one of the requisites of lasting advance in other fields

On the other hand it is I think, more than doubtful whether the removal of malnutrition by itself can be an incentive sufficiently powerful to make any rural African community increase its output, by which means alone the maintenance of proper nutritional standards would be economically possible

Everyone acquainted with Africa is aware of the value that the African places on leisure, and it is not too much to say that the desire for the long periods of leisure when an African sits and chats

The general consensus of opinion seems to be that Kwashiorkor is probably due to a deficiency of protein in the diet given to children after weaning The disease is serious not only because growth is retarded or even because in severe cases the child dies, but because quite probably permanent damage may be done to organs such as the liver and heart of those who survive Kwashiorkor is regarded by some as possibly the most important nutritional disease of the world both as regards frequency and severity and it may well affect the working capacity of entire communities While there is not yet sufficient statistical information or even agreement among experts to make a pronouncement on the subject, it is clear that if permanent damage is done even to a comparatively small proportion of an African community, that community is going to find it more difficult to support a reasonable standard of living - a standard which they have already got to improve to be considered satisfactory I think it fair to say that the incidence of kwashiorkor, its actual effect on the efficiency of adults who have suffered from it in childhood, and even its cure in severe cases, are still imperfectly understood, and while great strides have been made in treatment further research is still required to establish the extent of permanent damage in the severe cases which do not die That of course is the research side of the problem to which many nutrition experts present at this Conference have contributed so much There remains the problem of preventing Kwashiorkor and indeed improving nutrition generally No one point of attack can alone be effective and many weapons must be used if material success is to be achieved One essential is of course that the African himself must have a knowledge of the necessity for a balanced diet and desire to achieve it Possibly the most fruitful approach may even be through this very disease Kwashiorkor The African has more than his fair share of that most delightful of human traits - a love of children - and I believe that when African parents realize the benefits to their children of a balanced diet and the penalties of malnutrition, there will then be a powerful incentive to obtain that diet For that reason we must all welcome the increasing work in child welfare and the education of African mothers which is taking place throughout the Continent Quite clearly too it is desirable that children in school should be taught the value of a balanced diet and be trained to accept unusual foods

In addition to the educational problem, and I have referred only to two aspects of it, there must also be the means whereby a community, knowing the necessity for a balanced diet, can obtain it This is possibly one of the hardest nuts to crack because in the long run a community can only get out of life what it puts into it and because also crops which have the necessary nutrient content will have to be grown, this may prove to be a serious problem in those places where poor soil climate, over-population or other adverse factors have already forced the people from more nutritious crops to such crops as cassava Furthermore, foodstuffs when grown must be made palatable and acceptable Any alteration of feeding habits in a people is difficult at the best of times and this is particularly true in rural communities I have said that the shortage of protein is thought to be possibly the cause of

in contact with them But it is only comparatively recently, and due almost entirely to the researches of medical scientists, many of whom are in this room today, that the possible implications of malnutrition have been generally realized It is now being regarded with increasing concern in wide circles Not only has the London newspaper *The Times* devoted an article in its last *Quarterly Review of the Colonies* to nutritional problems in Africa, but articles by medical scientists in the *British Medical Journal* of October last called forth a leading article in the *Manchester Guardian* on the subject of kwashiorkor It is clear from the bibliography attached to the report 'Kwashiorkor in Africa' - published in the Food and Agriculture Organization's Nutritional Studies Series and in the Monograph Series of the World Health Organization - that this interest in the nutritional problem of Africa is widespread among all governments and people concerned in Africa, and that many medical scientists of many nationalities are making valuable contributions to the common problem It is only necessary to point to this Conference as an excellent example of the common interest in the matter and of how the United Nations Organization and other world organizations can co-operate with representatives from African territories

I must confess that until quite recently I had never heard of kwashiorkor, but as it is held in some circles to be one of the most widespread nutritional disorders and as discussion of it will take up a considerable part of the time of your Conference, I think it would be of help to those who are present at this opening address, but who are not members of the Conference, to understand something of the nature of the problems which you are tackling, if I were to give a short explanation of this particular disorder and its possible effects on the health and happiness of African communities You who are experts in the matter will forgive me, therefore, if I trespass on your time for a few moments I must confess that I have borrowed very freely from the articles which I have mentioned - and probably even from yourselves

It appears that 'kwashiorkor' is a West African term - from the Gold Coast I think - and refers to the reddish tint of the hair of African children, which was known to Africans to occur in certain children just after the time of their weaning It was first reported in medical literature about twenty years ago and it was observed that it was generally associated with symptoms of severe malnutrition - so severe that death was not unusual in advanced cases Since then the same or a similar disease pattern has been described in East Africa, in South Africa, in the West Indies, India, Central Europe, Egypt and Brazil Disorders caused by malnutrition in children have been given many different names but, generally speaking, experts are coming to apply the term 'kwashiorkor' to what is thought to be a recognizable disease pattern which occurs in children shortly after they have been weaned Some of the signs recognized by experts are retarded growth the swelling of the legs and the generally apathetic and miserable condition of the baby In extreme cases the disease can be fatal even when under treatment

I have tried, Gentlemen, in my address to summarize the importance to this continent of the subject of your Conference, a subject in which all of you are experts, and would wish you every success in your discussions and express my sense of privilege in addressing you this morning

I have pleasure in declaring this Conference open

Professor BIGWOOD replied on behalf of Delegates to the Conference

'Your Excellency,

On behalf of my colleagues of the various governmental delegations attending this Conference, I have pleasure in expressing our gratitude for having been invited to come to the Gambia with a view to discussing nutrition problems of mutual interest in Africa

We feel indebted to Her Majesty's Government in the United Kingdom for acting as host, on the occasion of this Second Inter-African Nutrition Conference of the CCTA, giving us thereby the opportunity of holding our meeting in their well known scientific and experimental field station in British West Africa

We all feel very grateful to you, Sir, for having so kindly honoured us by opening our first session today, we want to thank you most heartily Your gesture was a stimulating one for us

The first CCTA Nutrition Conference was convened by the French Government at Dschang in the Cameroons in 1949 It was a great success and has proved to have served a most useful purpose It gave to those who are in charge of improving food habits and food supply, of promoting research in nutrition and related health problems in those parts of the world where they are heavily loaded with difficulties, the opportunity to confront one another with their ideas and findings, to get in closer contact, to be personally known to each other and to work in more intimate co-operation When scientists devote their efforts to the study of problems which require their long-standing presence in such remote parts of the world as Central Africa, the lack of real and greatly needed contacts with the scientific world is inevitably badly felt In this respect too, conferences like the one we are attending today serve an essential purpose

Judging from its agenda and programme we feel confident, Sir that the present symposium will prove to be equally stimulating to all those who have been invited to attend it

We have heard a lot of the Medical Research Council's Field Unit in Fajara and know of the excellent work that has

kwashiorkor This immediately raises the question of fishing industries and other sources of protein There has always been a shortage of meat in Africa but an alteration of the attitude of the African towards cattle farming would go quite a long way to solving this particular aspect of the problem Indeed, a whole range of problems is integrated with this question of nutrition, and I have only touched on a few

This problem of malnutrition is of consequence in the Gambia Since the opening of the century we have not been self-supporting in foodstuffs and have relied on a cash crop - groundnuts Because of this many villages go through a period during the rains known as the hungry season' and as you will learn at this Conference, that period corresponds with the most unhealthy season of the year and, although we do not usually get famine, severe undernourishment and distress is quite common The Government is trying hard to abolish the hungry season and is pressing with all the means in its power a policy of growing more foodstuffs We have problems of soil impoverishment, local over-population in a few areas, and indebtedness, but nevertheless during the last two years we have made considerable strides - particularly in the cultivation of peasant rice The subject of this Conference is therefore one which is well fitted to be discussed in the Gambia

This is a conference of representatives of the Commission for Technical Co-operation in Africa South of the Sahara and we have delegates here from the Belgian, French, Portuguese and British territories in Africa, together with delegates from the Metropolitan countries, the Union of South Africa, Southern Rhodesia and the Sudan It is a matter of great regret to us all that Liberia has not been able to send a delegation

But in addition to the delegates attending the Conference we have distinguished observers taking part who represent many member countries of the World Health Organization and the Food and Agriculture Organization of the United Nations We also have present with us today observers representing the International Children's Centre and the Scientific Council for Africa I welcome this evidence of real international co-operation in a field which is so important not only to the people of Africa, but to human welfare generally

It may interest our visitors to learn that we have representatives here today from more than a score of countries and territories including Australia Belgium, France, Haiti, India, Italy, Portugal, the United States of America and of course from the Headquarters of the Food and Agriculture Organization in Rome and the World Health Organization in Geneva

I would like to take this opportunity of thanking the World Health Organization for the generous help it has given to this Conference in the form of clerical assistance, interpretation facilities and other assistance

The African Regional Office of WHO felt that much good might come out of the present gathering of scientists and practical men WHO was always concerned first and foremost that the schemes it was requested to support should be practicable and that any enterprise undertaken should be such that the Territory concerned could carry out the follow-up after WHO withdrawal

In the matter of nutrition, therefore, he earnestly hoped that the recommendations arising from the Conference, taking into account technical, cultural and anthropological considerations as well as purely medical ones, would lead to the best possible use of the money contributed to his organization by the Governments whose delegates were gathered round the table

Dr AYKROYD expressed appreciation of the opportunity given to the Food and Agricultural Organization of the United Nations (FAO) to be represented at the Nutrition Conference of the CCTA, and thanked the Government of the Gambia for its hospitality towards delegates FAO in common with WHO was happy to be associated with the CCTA in the present Conference, the results of which would be of great value to the Joint Expert Committee which was later to consider on a world basis the problems which the present Conference was to examine with respect to African territories

He expressed his personal pleasure at being able to represent FAO at the present Conference because he had participated in the earlier Conference on nutrition problems in Africa held by CCTA in 1949 at Dschang Since then FAO had co-operated with WHO in making the survey of kwashiorkor in Africa, which was carried out by M Autret of the Nutrition Division of FAO and Professor Brock. FAO attached great significance to the present meetings which it felt should lead to important and far-reaching results FAO itself was particularly interested in the problem of prevention He felt he could say on behalf of his own Organization and indeed of everyone present, that it was a great encouragement to know that His Excellency was so keenly aware of the nature of the problems which lay before the present Conference

The Secretary invited nominations for President from the Delegates of those Metropolitan and Territorial Governments who were members of the CCTA

Professor CAMBOURNAC proposed that Professor Platt be appointed President of the Conference

Professor BIGWOOD seconded the proposal

Professor PLATT was elected President by acclamation and took the Chair

The President said that he accepted with the deepest appreciation the honour his colleagues had conferred upon him This was, as

been going on there under the guidance of our colleague and friend, Dr Platt We should be grateful to him if he would kindly convey to the Medical Research Council our sincere thanks for having planned with him the organization of this meeting in Fajara We want him personally to share our thanks with them Under such auspices we are confident in the success of this gathering As I was listening to your speech, Sir, it occurred to me how gratifying it must be for those who are engaged in their studies in this scientific centre to realize that the high authorities governing this part of the world are so well and so clearly aware of the basic aspects of the scientific problems concerned and of their economic and social implications Apart from those of us who are engaged in the study of African nutrition problems either in their European laboratories or directly in Africa, we are privileged in having also with us prominent colleagues working along similar lines in various other parts of the world They are not only known to most of us but they are personal friends of many of us within the nutritionists' international community It is with pleasure that we greet them here I am sure I am voicing the feeling of all of us who are gathered here, in assuring you, Sir, that our gratitude is deep our pleasure is genuine, our confidence in the usefulness of such meetings is great and so is also our desire to bring our full share to the common effort towards constructive co-operation '

Lt-Gen DAUBENTON said that it was a great pleasure to him to be able to be present on behalf of the World Health Organization at the present Conference He expressed his gratitude to the Director of the Field Research Station, to the United Kingdom Colonial Office and, particularly, to the Governor of the Gambia He added that the expert Committee of WHO which was to meet immediately after the end of the present Conference was very grateful for the invitation extended to it to make use of the facilities prepared for the CCTA Conference

Outlining the events which had led up to the convening of the present joint Conference, he said that the Expert Committee of WHO had decided in 1949 to ask Professor Brock to conduct a survey of the incidence of kwashiorkor in African territories With the co-operation of the Food and Agricultural Organization of the United Nations (FAO) that survey had been completed in 1950 In October 1950 the Director of the Africa Regional Office of WHO had included an item in the 1952 Budget to be devoted to a conference of experts which was to examine the survey Meanwhile it had become known that the CCTA intended to convene a Conference on Nutrition Subsequently for the sake of economy and concentration of effort it had been decided to run the two meetings consecutively making use of common facilities It was in this way that the present meeting had come about It was, therefore, particularly gratifying for him to take part in a conference on problems of a kind which were of particular interest to the Regional Office for Africa of WHO i e those of malnutrition and its effects in African territories

Chairman Professor A A. Moncrieff

CLINICAL ASPECTS OF KWASHIORKOR IN FRENCH WEST AFRICA

by

A Raoult

Much work has been done on nutritional diseases in French West Africa during recent years, particularly on the problem of kwashiorkor In the research on this subject the hospital physicians in Dakar and the investigative body of the Anthropological Mission on food and nutrition have taken part, assisted by the Pasteur Institute in Dakar and the Transfusion Centre of French West Africa

Bergeret[2] has given a clear statement of the problem with a historical study and a clinical picture of the disease as it is seen in Dakar His description only differs from other now well known descriptions in regard to the frequency and often the severity of the mucocutaneous lesions He notes two main characteristics fatty liver, the fat being predominantly in the perilobular region, and atrophy of the mucosa of the small intestine

Aetiological factors are considered The dietary of children was deficient in animal protein with carbohydrates predominating and usually the same as that of the adult (mainly rice, millet or maize) with different fatty foods added according to the region, this food was indigestible for the weanling There was at first a slight protein deficiency which was later aggravated by the lack of digestive enzymes caused by chronic enterocolitis The increasing amino-acid requirements for growth, and parasitic infections, particularly malaria, further aggravated the situation Thus, kwashiorkor in Dakar appeared mainly as a deficiency disease conditioned by disordered digestion, itself caused by faulty diet Bergeret considers the only valid therapy to be a good milk diet with easily assimilated protein added and the injection of human plasma The mortality in severe cases was 80 per cent, but it was brought down to 20 per cent when the minor forms of the disease were diagnosed early Infections and parasitic diseases appeared to have an important effect upon the high mortality rate

Shortly afterwards, *Bergouniou and Tremolieres*[6] also made a general review of the problem and presented their contribution to the study of fatty degeneration of the liver in the African child They state the position of this disease in relation to cirrhosis and primary carcinoma of the liver in adults They draw a detailed clinical picture - now classical - which may be summarized as follows

His Excellency had said, an historic occasion, it was for him a reward which he would always treasure He wished to acknowledge the help of his staff, past and present, both in the Gambia and in London, in establishing the MRC Research Station, and in building up the reputation of 'MRC Fajara', of which he and his colleagues were proud and for which they were so jealous He was particularly glad of an opportunity to thank the members of the African staff of the Station for their loyal service - most of them had been there for the greater part of the short life of the Station Delegates would, he hoped, enjoy their willing, happy aid during the Conference An important factor in all the work of the Station had been the co-operation of members of the Gambia Government - particularly the staff of the Medical Department - but most important of all had been the trust placed in the staff by the Gambian people in the villages in which they had worked

He was glad to have the opportunity of adding his thanks to those of his colleagues for His Excellency's welcome to them today They were all pleased that so many interested in the problem of malnutrition in mothers, infants and children in Africa and elsewhere in the world had been able to meet to discuss the subject

It was inevitable that there were some whom they would have wished to have had with them but who, for various reasons, could not be at the Conference or at the Joint Committee of the World Health Organization and the Food and Agriculture Organization

He had indeed hoped that the former Secretary of the Medical Research Council, Sir Edward Mellanby, might have led the United Kingdom delegation Many of those present owed a great deal to his inspiration and leadership and the President thought they should know that without his help and interest the Research Station would not have been established He was sure Sir Edward would wish him to express his regrets at not being able to accept the invitation to attend this Conference

The subject of the Conference was malnutrition in infants and young children, and in mothers in so far as it affected that of their offspring The various signs and symptoms of diseases due to malnutrition in infants and young children would be examined the changes occurring in the tissues of the body in malnutrition would be studied the evidence for effective treatments would be scrutinized and it was hoped that the ways and means by which the common kinds of malnutrition might be prevented would be explored

He was sure his colleagues would all agree with him that the present was a most opportune time in the history of the subject to meet for a discussion Indeed it was only recently that enough had become known about the kinds of malnutrition still prevalent in Africa, in parts of the Americas Europe and Asia, to enable those concerned to contemplate making substantial progress in the understanding of their subject with hope and confidence

age of two years or more, but the flaccid breasts of the mother produce only a yellowish liquid without much nutritive value When the child is about eight months old, the mother begins to make it ingest carbohydrates to which are very soon added various sauces Their composition varies according to the district, and a distinction is made between cereal eaters (millet, sorghum, fonio in the form of couscous*, and rice) in the town of Dakar, and those in the forest areas who eat cassava, sweet potatoes and taro According to the district, place and race, the sauces may contain (a) oil-containing foods groundnuts and gourd seeds (pounded) (b) red palm oil, and oils from shea nuts and cotton seeds (c) condiments and mucilaginous products (d) fresh vegetables (e) fresh or dried fish, and occasionally dried meat Very little cow's milk is taken except by the pastoral Peuls The food given to the African child seems in general to be unsuitable, except the 'rouy' (a fermented millet pap) of the Wolof tribe

The authors give a general review of the pathogenesis of the hepatic lesion, with special consideration of the deposition of fat in the liver The various forms of treatment are enumerated in the light of the results of animal experiments The appearance of the pancreatic lesions is similar to that observed by Véghel,i *et al*[18] The mechanism of oedema caused by faulty nutrition is recalled, the various types of mucocutaneous lesions are attributed to vitamin deficiencies

Deficiency of vitamin A as such in diets in the Dakar region is undoubted The occurrence of carotene deficiency is less certain, there may, however, be impaired absorption or retention by the liver There is certainly a deficiency in riboflavin and pantothenic acid nicotinamide deficiency is less probable Thus it seems certain that while some signs of avitaminosis are due to dietary deficiency, others are due to deficiencies in the digestion or utilization of the diet, which are secondary to the hepatic involvement

Diarrhoea is linked to a deficiency in the pancreatic or other digestive enzymes Under such conditions millet couscous is imperfectly digested

In the view of these authors, the determining cause of the syndrome is the relative or absolute deficiency in lipotropic factors, to which are added the effects of multiple avitaminoses Serious developments occur when there is a lack of balance in the diet between carbohydrates and fats on the one hand and proteins on the other, with a high calorie ratio to which the level of the lipotropic factors ingested no longer corresponds

These authors also recommend the use of skimmed milk powder or acidified partially skimmed milk, and plasma transfusions

They summarize their work, which also includes a study of experimental cirrhoses and carcinoma of the African liver, in the following manner-

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* The grains reduced to meal granulated and then flavoured by steaming over meat etc

(a) discoloured hair, modified in texture
(b) discoloured and fragile skin with multiple lesions
(c) oedema of the face and extremities, partly masking the loss of weight of the patient
(d) a large, fatty liver with a deficiency of all digestive secretions
(e) loss of blood protein, particularly of the serum albumin
(f) fatty liver, shown by biopsy, and degeneration of the pancreas as well as fatty liver shown by necropsy
(g) such severity of the condition that the lesion seemed to be irreversible
(i) considerably retarded growth in all cases

These authors present a historical study containing the various names given to the disease, and showing that it is distributed throughout the tropics

In a chapter devoted to the variable characteristics of kwashiorkor, they stress the fact that different authors have not all seen kwashiorkor in the same form There were intermediate types between the severe cases at the Central Hospital at Dakar and Waterlow's[19] cases showing only fatty liver There was in different areas considerable variation in the skin manifestations These manifestations were the expression of secondary avitaminosis or of a deficiency in some amino-acid Diarrhoea and steatorrhoea which were always seen in patients in Dakar were not invariably found elsewhere Sometimes the patients did not have discoloured hair Thus, the only invariable characteristic appeared to be fatty degeneration of the liver, which was sometimes the only sign of the disease although the term 'kwashiorkor' continued to be applied to it Degeneration of the pancreas was mentioned as being probably the original lesion, but it has not yet been systematically studied in Dakar Laboratory examinations showed increased basal metabolism, a low level of serum albumin, and a relatively high level of α- and γ-globulins, giving an inverse serum albumin globulin ratio There was increased lipaemia (of neutral fats) and a slight reduction in phospholipids All the liver tests showed abnormal reactions

In discussing aetiology attention is drawn to two hypotheses which have developed, the first attributing the disease to vitamin deficiency and the second to a protein deficiency, various authors seem to have agreed on the second, but Bergouniou and Trémolieres point out that the two views are not mutually exclusive in view of the relationships and links between vitamins and proteins Protein deficiency would inevitably cause a deficiency in lipotropic factors and in vitamins of the B complex They consider that digestive troubles are secondary to lesions of the digestive glands, particularly of the pancreas

The authors then consider the different weaning methods among Europeans and among the various African groups The African child is weaned much later than the European, being breast-fed until the

Local characteristics seemed to be due to the diversity of clinical forms among which, in addition to those due to malnutrition alone, could be distinguished (a) forms concurrent with (i) parasitic infestations, either of the intestines (ascariasis in one-third of cases), or of the blood (*Plasmodium falciparum* malaria in one-third of cases), and (ii) infections, particularly otoantritis, pneumonitis and tuberculosis, (b) forms secondary to a primary tuberculous infection, severe malaria, or severe whooping-cough, (c) latent forms, showing, in 50 per cent of the cases, fibrosis of the pancreas, shrinking of the exocrine glands, or hyperplasia of the islets of Langerhans The forms of steatosis of the liver in conditions clinically different from frank kwashiorkor showed a different distribution of fat which 10 times out of 13 was predominantly centrilobular rather than perilobular

Non-treated cases tended to be fatal as a result either of some intercurrent infection or of general debility Cases treated sufficiently early showed rapid decline of the oedema, and healing of skin lesions, although the diarrhoea responded more slowly The surest sign of approaching cure was an improvement in mental outlook

Camain and Pierchon[9] made histological examinations of material from 34 necropsies and found that the hepatic and pancreatic lesions were very similar to those observed by Waterlow[19], Hartz[12], Veghelyi *et al*[18] and Davies[11]

In the pancreas there was constant exocrine gland atresia resulting in a pseudo-lymphoid appearance, and in one-third of the cases the islets were hyperplastic There was increased connective tissue in 50 per cent of the cases

The authors outline a pathogenesis of kwashiorkor based on elective involvement of the pancreas with insular hyperplasia and new growth of beta cells affecting the alpha cells They suggest that there is hyperinsulinism and a deficiency in lipocaic hormones

In the liver, excess fat was absent in up to 15 per cent of the cases, in spite of pancreatic involvement In mild forms the fat infiltrated only the peripheral cells of the liver lobule In severe forms the entire lobule was infiltrated, but the fat was predominantly periportal The cell nucleus appeared unchanged The connective tissue was examined by silver techniques Fifty per cent of the cases showed hyperplasia of the precollagenous interlobular reticulum and sometimes a slight increase of the connective tissue of the biliary-portal tract Fairly frequently the kidneys were found to have more or less heavy deposits of fat in the cells of the convoluted tubules, the degree of severity of this steatosis followed that of the liver There were very variable changes in the suprarenal glands The skin was not very closely studied A paper on skin lesions by Berte[7] is given elsewhere in this Report

(a) Kwashiorkor is a malignant and rapid form of nutritional cirrhosis which appears in the African infant at weaning
(b) this cirrhosis is due to a deficiency in the infant's diet of the lipotropic factors necessary for the normal metabolic functions of the liver
(c) a cure can only be effected by continued treatment with high protein diets, providing 6 to 7g of protein per kg of body weight daily
(d) certain abortive forms of kwashiorkor exist which may be the cause of a certain number of adult cirrhoses if the lack of dietary balance is continued
(e) the defects of the diet of the majority of Africans in French West Africa, with the animal protein deficiency involved, are sufficient to explain the majority of post-weaning cirrhoses
(f) these nutritional cirrhoses are the basis of most cases of carcinoma of the liver

Bergouniou later continued his investigations of the nutritional state of the French West African population, studying two very different areas the Upper Volta and the Cape Verde peninsula [4] He found

(a) there was no kwashiorkor in the part of the Upper Volta surveyed
(b) kwashiorkor occurred with varying frequency in the villages of the Cape Verde peninsula, where the diet very early in life was plentiful but too rich in carbohydrates and unsuitable for infants, it was also too rich in lipids, particularly groundnut sauces and groundnut milk, in the villages most affected, too much indigestible fish was consumed
(c) malaria was very frequent in the Cape Verde peninsula but no more frequent than in the Upper Volta where the diet was balanced but excessive

Studies were continued in Dakar in 1951-2 by the paediatric service which I directed, these studies[5,9 15] were two-fold in purpose (a) to obtain yet more clinical, aetiological and histological information, particularly concerning the pancreas, which had so far been little studied in Dakar and (b), to continue therapeutic tests

Pierchon's[15] thesis deals with observations on 78 patients The usual clinical signs seen at Dakar were at the onset, diarrhoea resistant to all treatment, and frequently steatorrhoea, and, at full development, very variable enlargement of the liver He has described the mucocutaneous lesions and detailed studies of the appearance of the hair, from which it is apparent that the hair of the African child suffering from any severe chronic condition turns red

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The disease occurred from August to February, was particularly prevalent during the four months of the rainy season and reached a peak in September to October This is also the time of seasonal malaria in Dakar and the period when the protein intake is largely from dried fish The greatest number of cases occurred about the age of 18 months

The diet was also studied by *Raoult and Pierchon*[15] and the work of Bergeret and Bergouniou confirmed The disorder was considered to be due largely to the fact that the mother's milk soon becomes insufficient and is too rich in fatty substances, containing 4 7g per cent of lipids, as opposed to 3 5g per cent among European women in Dakar African children always pass fairly abruptly from the breast to the adult diet of rice or millet couscous, with sauces, fish, or more rarely, meat The lack of balance between carbohydrates and proteins, rather than a true protein deficiency, is held to be the cause of the disease The diet of the Cape Verde child frequently contains a theoretically sufficient quantity of proteins which seem to be badly absorbed, certain fish appear to be badly tolerated by the young The question is raised whether certain species of fish might contain anti-enzymes (antimetabolites) In Senegal, the groundnut might be responsible, experimental cirrhoses have been induced with a diet of groundnut cake[1]

Therapy with androgens and skimmed milk combined is discussed and the results obtained are given Mention is made of various tests with cortisone pregneninolone acetate, and aureomycin[10]

It has not been possible in the Dakar laboratories to study the pancreatic enzymes. Schachmann's test, although convenient, has proved inadequate

The work in hand at the moment includes systematic examination of the liver biopsies from children of different ages, this is being done under Professor Senecal at Dakar Central Hospital Systematic X-ray studies of the bone structure of his patients have revealed a number of interesting points and show the frequency of osteoporosis

In the field, an experimental centre has recently been established at Popenguine for the purpose of conducting a continued and thorough study in one area where between 10 and 20 per cent of children of weaning age suffer from kwashiorkor and where various signs of malnutrition are seen up to the age of 12 or 13 years As a parallel measure, some 1,500 children are being treated with skimmed milk they are followed up at regular intervals and their histories are recorded This measure is very well received by the population At the same centre, treatment tests are being made of the use of skimmed milk alone, milk and androgens, and the administration with powdered milk of a new product which had been used for veterinary purposes and which contains the animal protein

factor and is composed of cyanocobalamin (vitamin B_{12}), aureomycin and procaine penicillin It is still too early to publish the results which, however, appear to be favourable so far, but we can show some case histories Our studies on lactating women are still proceeding

While the laboratories were still getting under way, it seemed to us preferable to establish general findings before studying any particular category In that light we contribute the work of Linhard *et al*[13] on proteinaemia and calcaemia in the African of the Dakar region The work of Bergouniou on dietary studies in Upper Volta and on Cape Verde complements that of Pales and his co-workers Auffret and Tanguay[14]

Most of the food products consumed in French West Africa, and particularly those of vegetable origin, have been analysed in dietary tables by Randoin[16] and are reported in publications of the Anthropological Mission Busson *et al* [8] have analysed fish of the Senegal coast We still need more equipment and qualified staff to be able to cover French West Africa in our investigations and to carry out the necessary biochemical research

The true incidence of kwashiorkor in French West Africa is still not known We do, however, know that, while it is the exception in some areas, it is very prevalent in Dakar and in certain divisions of Senegal where the part it plays in the general infant mortality rate is far from negligible, but we should be careful not to generalize We have the impression that in French West Africa the problem is largely a local one on quite a small scale and must be solved in each territory by different means

The example of the children of the Lebous fishermen shows that the aetiological problem is far from simple It is not merely a question of a total deficiency in animal protein, it is frequently necessary to interpret a complex of conditioned deficiencies

It seems impossible in our territories to eliminate the high incidence of malaria which must precipitate accidents when the dietary balance is precarious

Kwashiorkor is a syndrome of which the clinical signs may be independent of each other and difficult to define Hepatic and pancreatic lesions, which are fundamental, are the end result not only of dietary disequilibrium, of starch dystrophy ('dystrophie des farineux'), or of exaggerated intake of lipids and carbohydrates by Africans in certain regions, but also of a series of attacks on the pancreas, the liver, and very probably the endocrine system A series of stresses, occurring at the time of maximum growth, seems to help to precipitate the disequilibrium in protein in African children

I feel, therefore, that in French West Africa the problems of nutrition and those of malaria and the numerous other parasitic infestations are inseparable Our dietary problem is not - or, at any rate, does not seem to be - always very acute, but malaria is rife everywhere and it is just as necessary to treat and prevent malaria in a child as it is to nourish him properly in order to prevent kwashiorkor

REFERENCES

1 Aubertin, E , Riviere, J , Loiseau, P , Depot, P & Malineau, R *(1952) Rev internat hépatol* , 2, 425

2 Bergeret, C *(1951) Sem Hôp Paris* No 47, 2036

3 Bergouniou, J -L *(1951) Bull med A O F* , 7, 201

4 Bergouniou, J -L *(1952) Bull méd A O F* , 9, 51

5 Bergouniou, J -L & Raoult, A *(1952) Bull med A O F* , 9, 71

6 Bergouniou, J -L & Trémolieres, J *(1952) Bull Soc Pat exot* , 45, 113, 242

7 Berte, M *This Report p* 111

8 Busson, F , Postel, E & Giraud, F *(1953) Bull med A O F* , *in press*

9 Camain, R & Pierchon, M *(1952) Sem Hôp Paris* No 50, 2169

10 Charmot, G , Charmot, F & Le Henand, F *(1952) Sem Hôp Paris* Nos 59-60, 2438

11 Davies, J N P *(1948) Lancet*, i, 317

12 Hartz, P H *(1949) Docum neerl indones Morb trop* 1, 41

13 Linhard, J , Busson, F & Giraud, F *(1953) This Report, p*

14 Pales, L , Auffret, C & Tanquay, F *(1947) Report No 3, Mission Anthropologique A O F*

15 Pierchon, M *(1952) A contribution to the study of kwashiorkor on the Cape Verde Peninsula Thesis Bordeaux*

16 Randoin, L *(1947) Report No 3 Mission Anthropologique A O F*

17 Raoult, A & Pierchon, M *(1952) Sem Hôp Paris*, No 50, 2169

18 Véghelyi, P V , Kémeny, T T Pozsonyi, J E & Sós, J *(1950) Amer J Dis Child* 79, 658

19 Waterlow, J C *(1948) Spec Rep Ser med Res Coun , Lond* , No 263

UNDERNUTRITION AND KWASHIORKOR IN UGANDA

by

H. C Trowell

My colleagues and Ihave attempted to summarize our knowledge concerning the disease of kwashiorkor as seen in Uganda[2,4,5] and in a book, the manuscript of which is almost complete, we have surveyed the problem of this disease against more than 300 original communications from many parts of the world. Those who work in the children's ward at Mulago hospital are in agreement concerning the main facts as seen in severe cases, of which there are usually from two to ten in the hospital at any season of the year. Autopsy is performed on over half the fatal cases. The investigation of the far more numerous cases of mild kwashiorkor in children in Uganda has been less thorough, I consider that a very large proportion of the children in Uganda suffer mildly from this condition, at least during the early years of life. Professor Davies, Professor Holmes and I are only at the beginning of the investigation of protein deficiency states in adults, but it is considered by some of us that the biochemical and pathological patterns laid down in kwashiorkor in childhood tend to recur in adult life, and in Uganda certain of them may even persist from the time of their inception during infancy.

The diet at any age should supply the correct amount of fluid, calories and protein. After weaning, protein should contribute from 12 to 14 per cent of the calories, the higher figure being required in early childhood when kwashiorkor is always far more common. The body reacts to a severe shortage of any of these dietary essentials in a characteristic manner, yet it is only in recent years that the problems, firstly of dehydration, fluid and electrolyte balance, secondly of under nutrition, cachexia, marasmus, hunger oedema and calorie deficiency, and thirdly of kwashiorkor and protein inadequacy, have been clearly envisaged. The inclusion recently of kwashiorkor in the foregoing triad is of importance in view of the relationship of dietary protein, especially in young children, to the formation of enzymes, hormones and antibodies.

During the first few months of life the rate of growth is almost the same among breast-fed infants of all races, and no difference should be accepted on the basis of race or climate until the common causes of unsatisfactory growth have been excluded. There may be three reasons why an infant does not thrive and grow normally.

Firstly, an infection may be responsible It is usually possible to obtain proof of its presence and of its nature, and to apply specific therapy If the infection is correctly treated, growth, which may have been very unsatisfactory during the period of the disease, should return rapidly to the normal rate In the tropics, infections have been blamed far too much for all serious failure of growth. It is now possible to prove or disprove this contention by administering specific therapy

The second reason for failure of growth is undernutrition, which occurs when a diet contains the correct proportion of calories, protein, salts and vitamins but is reduced equally in all its constituents until it no longer satisfies all the requirements. The underfed patient invariably becomes hungry and actively seeks food. This is common among young infants fed on insufficient amounts of normal human breast or cow's milk. If, later in childhood, the previously well balanced diet (protein contributing 14 per cent of the calories - a somewhat rare occurrence in many tropical countries) is reduced for any reason, general undernutrition results. In infants marasmus occurs, later in life cachexia dominates the picture. There is always an early and complete disappearance of all subcutaneous fat eventually slight oedema* may occur but is usually absent. The abdomen remains scaphoid and hollow, the face is sunken and the hair, although dry, soft and with little sheen, suffers only a slight loss of its pigment The skin may become pale and lose some pigment it becomes dry and rough. The serum proteins usually remain almost normal, this also applies to the structure of the liver and pancreas Hunger continues to dominate all mental and bodily activity, almost up to the moment of death The bowels are usually dry and constipated but diarrhoea at times may occur. Upon refeeding, very rapid progress is made and cases which enter hospital are usually saved if they survive the first few hours In our experience in Uganda, undernutrition is only common in the first few months of life when the breast milk has failed and diluted cow's milk has been substituted Later in childhood, neglected children usually manage to beg enough food from their neighbours. Undernutrition is uncommon in Uganda where there are two crops of food each year and almost no destitution in large towns or villages There is probably a fair amount of mild undernutrition in the drier parts of Africa, especially in areas where there is only one crop a year and the rainfall is uncertain It may occur in areas of over-population and where there is destitution in towns.

The third reason why infants do not thrive appears to be that
they are given a diet which contains too low a proportion of protein,
though it is adequate in amount to satisfy hunger. This we regard
as being firmly established as the cause of all cases of severe
kwashiorkor and as the reason why so many children in the tropics do
not thrive and have signs suggestive of mild kwashiorkor. It is
most important to understand what we mean by a low proportion of
protein. Infants probably should receive about 14 per cent of their
calories from protein, especially if much of it is derived from veg-
etable sources It is not sufficient, in our opinion, to discuss
the total amount of protein eaten or to talk of protein deficiency,
for it is the proportion in the diet which decides the patterns
imposed on metabolism. The proportion of calories derived from
protein is approximately whole cow's milk 15 to 20 per cent,

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* In the older text-books of medicine this condition was sometimes called nutritional oedema this term included cases of beriberi, hunger oedema should not be used

Res

wheat and sorghum, 11 to 12 per cent - maize has almost the same proportion but lacks one essential amino-acid, finger millet and rice, 7 to 9 per cent, plantains, yams and potatoes, 3 to 6 per cent, cassava, about 2 per cent

The constant features of severe kwashiorkor are a markedly subnormal weight, unexplained by an infection or other disease, profound mental apathy coupled with peevishness on being disturbed, and the passage of loose stools containing undigested food which reflects the reduction in the pancreatic enzymes The serum albumin is always considerably reduced so that oedema is often present The child is seriously ill and often dies unless the diet is suitably improved Treatment is not easy, partly because almost all advanced cases show some aversion to food, and partly because there is an intolerance of whole cow's milk and fat and even to many forms of carbohydrate Some anaemia is usually present but it is seldom severe unless complicated by infection The pathology in fatal cases is described by Professor Davies[1], it consists in typical changes in the pancreas and liver The rapid recovery of the serum albumin and of the pancreatic enzymes has already been mentioned and a detailed study of the complex biochemical changes seen in Uganda[3] displays a constant pattern decreased serum alkaline phosphatase, cholinesterase and amylase, with a low blood urea and cholesterol

Cases of severe kwashiorkor even in infancy may display certain **variable features** which, if not recognized, make diagnosis difficult Anaemia has already been mentioned The others include (a) degree of fatty infiltration in the liver and the degree of its enlargement, (b) degree or absence of oedema, (c) presence of subcutaneous fat, (d) changes in the hair and skin, (e) presence of the associated vitamin deficiencies and (f) infection which, especially in the tropics, may bedevil the fundamental nutritional picture and make extra demands on protein metabolism None of these features alters significantly the basic clinical, biochemical or pathological picture all of them appear to be due to protein inadequacy and disappear when the diet is corrected

It is quite certain that hepatic enlargement is very rare in Uganda A survey of the literature would suggest that in certain parts of the world enlargement of the liver is common in kwashiorkor and that this organ may show more fatty infiltration than is encountered in Uganda If enlargement of the liver is found to be due to malaria, to other infections, or is not due essentially to the accumulation of fat, then one is dealing with a completely separate problem, although all these diseases may occur in children who also have either severe or mild kwashiorkor Why fatty liver is more severe in some parts of the world will probably eventually be explained in terms of the varying types of metabolism of lipotropic factors in kwashiorkor and cannot be discussed here Professor Davies and I consider fatty infiltration of the liver does not explain the stellate fibrosis which radiates outwards from the portal tracts along the edges of the hepatic lobules The mystery of this portal tract lesion as it is seen in Uganda is that long after all

fat has disappeared from the biopsy specimen and long after all clinical signs of severe kwashiorkor have disappeared, the cellular collections remain, the reticulin continues to thicken and the fibrosis slowly increases even during adult life. It appears necessary to postulate some mild and chronic but inconspicuous degenerative change in the liver cells, which possibly continues to reflect the effects of tropical diets containing few cereals and so very inadequate in protein Stellate fibrosis of the portal tracts in varying degrees is present in the majority of adult African livers as seen at autopsy in Uganda, and many snow frank cirrhosis.

Oedema is present in almost all cases of severe kwashiorkor in Uganda occasionally it is severe as in acute nephritis In this connection it should be noted that slight albuminuria, without cells or casts, is common in kwashiorkor, so that unless care is taken the oedema may be ascribed to renal disease. Possibly the oedema is more severe in cases in Kenya and South Africa, whether this occurs in those taking much maize is uncertain, but the fact that much of this cereal is taken in both countries is interesting Possibly less oedema is seen where the diet is composed of millet or rice, as in the Sudan and in the Gambia. Whether there is any associated disturbance of the metabolism of the antidiuretic factor is uncertain, but a low serum albumin appears to be an inadequate explanation of the severity of the oedema Other cases may have no oedema and these are often misdiagnosed as cases of general undernutrition they never respond to an increase of the previous diet but only to correction of the proportion of protein, thus indicating that the correct diagnosis is kwashiorkor

The amount of subcutaneous fat varies, if present, the diagnosis of severe undernutrition is excluded, but often, after the oedema of kwashiorkor has disappeared from cases in which it has been severe, one is left with an extremely wasted child having a loose skin, no subcutaneous fat, and much reduction and flabbiness of the muscles. Beyond saying that some subcutaneous fat is found in many early cases but tends to be lost in the more chronic cases, I do not feel I can offer any useful observations on this point. It should, however, be noted that many doctors almost refuse to diagnose malnutrition if there is any subcutaneous fat the latter is related to calorie intake and may be present even in protein deficiency, which, however, always causes wasting of the muscles

Ectodermal changes are not an invariable feature, since these manifestations are so readily observed, the variability of their occurrence has been a puzzle to many Almost all cases of severe kwashiorkor in Uganda show some softening and browning of the negroid hair and some loss of pigmentation of the skin, most clearly seen as a circumoral pallor. A change in the texture of the hair appears to be the most constant feature Occasionally the hair appears to be jet black, although softer and straighter than normal There is no doubt at all that some dyspigmentary changes are more obvious if the hair is allowed to remain long, as in Uganda, and these signs are not seen if the hair is closely cut or shaved. This

question of the length of hair introduces an unfortunate complication and one should always, therefore, concentrate on the colour of the hair at the very roots. In Uganda it is rare to see the straw-coloured, greyish or nearly white hair seen in this disease in some other parts of Africa, but the reason for this is not known. In Uganda, after giving high protein diets, some change of texture and of curliness of the hair is noted within two or three weeks, later, a slight darkening of the scalp hair occurs, finally, the roots are seen to be jet black (this is more obvious if a part of the scalp is shaved). Scalp hair which has previously formed, although improving under treatment, probably never becomes completely normal. This must be clearly understood or we shall never grasp the malnutritional significance of the brown negroid hair commonly seen in apparently healthy young African children, a point which will be discussed later in relation to mild kwashiorkor.

In Uganda where kwashiorkor occurs usually in the second year of life, the black plaques of desquamative dermatosis (as I prefer to call the crazy-pavement) commence in the inguinal region and napkin area. In other parts of Africa and especially among rather older children the dermatosis occurs as small coalescing plaques which appear over all areas of pressure and irritation, such as the knees, elbows and ankles. It never has the typical distribution of classical pellagra on the areas exposed to sunlight. The dermatosis is only present in certain cases as a terminal condition, and the diagnosis should never be withheld because of its absence. Although resembling histologically and to the naked eye a pellagrous dermatosis, its distribution and quick response to milk protein show that it has important differences from that of classical pellagra. In severe, untreated cases extensive areas of desquamation may be seen, occasionally bullae, which resemble small burns, may occur over the dorsum of the foot, but even more distinctive are the fissures that occur at all the skin flexures. These three dermatological manifestations are probably peculiar to kwashiorkor. More crackling of the skin, especially over the shins, sometimes called mosaic skin, occurs in kwashiorkor but is probably not specific and may occur in chronic undernutrition. It is not proposed to discuss in any detail the signs due to an associated deficiency of vitamin A, riboflavin or other recognized vitamin deficiency, for these are very inconstant and of no fundamental significance.

The important point about all these signs is that even those which are ascribed to a vitamin deficiency improve after large amounts of milk protein have been given for a long period combined, of course, with a suitable diet. Other proteins doubtless help, but nothing at present equals the effects of treatment with powdered skimmed milk, which should be given as such, or mixed with the food, or given with only a small amount of water. The treatment of kwashiorkor by vegetable protein has been discussed elsewhere[1]. When milk protein is given the serum albumin and the pancreatic enzymes respond very rapidly and the oedema disappears, so that the weight at first falls. Eventually weight is gained but often slowly, and recovery is always most protracted and completely

different from the rapid response of undernourished children of the same age to a balanced diet Very young infants may, however, recover very slowly from general undernutrition and marasmus.

Malnutritional diseases were recognized first in a few serious cases which were studied in hospital, after this, many minor cases were recognized Kwashiorkor is no exception but it is extremely difficult to decide what constitutes mild kwashiorkor. It usually shows itself in a child of one to four years of age who is markedly underweight and has soft dyspigmented hair This failure of growth is not explained by infection or by undernutrition, and it is best cured by adding large amounts of skimmed milk protein to the diet, examination of which reveals a low proportion of protein. In Uganda soft brown hair is seldom seen below six months of age unless the child has been given much starchy gruel or pap, for this upsets straight away the proportion of protein in the daily diet. Breast feeding, therefore, does not completely protect against mild kwashiorkor, and is possibly less effective than cow's milk which is considerably richer in protein. This brown hair is commonly seen in Uganda among all poor African children and among a few poorly fed Indian children, the latter, however, like the African children in the Gambia, very seldom develop severe kwashiorkor, although cases have been seen in Kampala Brown hair is usually absent among the children of pastoral tribes in East Africa and among children who receive a pint or more of cow's milk daily

There are, however, among full-blooded Africans several kinds of dyspigmented hair which are not due to the presence of mild kwashiorkor. Slight softening and some dyspigmentation may occur in undernutrition, especially in youhg children. These changes may appear during tuberculosis, hookworm disease, cirrhosis and all diseases which disturb protein metabolism. A few Africans, especially in West Africa, have a curious carroty-red hair all their lives this, presumably, is due to some genetic factor Admixture with other races can produce great variety of colour and texture. Crisp black hair may bleach at the tips if exposed to sun, salt water or trauma.

In conclusion, I do not wish to plead for a word 'kwashiorkor' but for a conception. It answers the question why children do not grow well, what happens in their bodies, why they are not cured (unless complicated by undernutrition) when given more ordinary food, but why they must obtain expensive protein It explains what may happen not so much in their hair, which is unimportant, but in the liver and pancreas, which is very important It explains why many of them in tropical regions do not grow into completely normal human beings.

Summary

The broad patterns of undernutrition and kwashiorkor are described unsatisfactory growth is usually due to one of these varieties of malnutrition or to an infection The constant and the variable features of cases of severe kwashiorkor are described

none of the latter affect the basic picture present in all cases of the disease. Cases of mild kwashiorkor are probably very common, but are difficult to diagnose since there are many causes of dyspigmentation of the negroid hair All features of mild kwashiorkor respond slowly to the addition of skimmed milk protein to the diet

REFERENCES

1 Davies, J. N. P. *This Report, p 109*

2 Dean, R. F. A. *(1952) Brit med J*, ii, *791*

3 Dean, R F. A & Schwartz, R *(1953) Brit J Nutr*, 7, *131*

4 Trowell, H C & Davies, J. N. P. *(1952) Brit med J*, ii, *796*

5 Trowell, H. C, Davies, J N P & Dean, R. F A *(1952) Brit med J*, ii, *798*

KWASHIORKOR IN BASUTOLAND

by

K. E. A Underwood Ground

Although kwashiorkor had been described previously in South Africa, Basutoland children with oedema were, until 1949, regarded as having infantile beriberi, avitaminosis or 'protein anaemia'[3] recently it has been realized that these were probably examples of kwashiorkor (see plate 1). This paper deals with observations on 26 patients in the children's wards at Maseru Hospital, the data obtained are summarized in the table.

Incidence In the Annual Nosological tables kwashiorkor is not included as such, but it is probable that the majority of 'other deficiency diseases' reported reflect to some degree the general incidence of kwashiorkor. The majority of cases occur in the Northern lowlands, where maize is the staple diet. In the mountain areas, where more meat is available and wheat is eaten more often than maize, the disease is practically unknown. Of the 26 cases under consideration, 15 were males and 11 females 10 were between three and four years, and 7 between two and three years of age. Maximum incidence is in late summer and early winter It is interesting to note with regard to seasonal incidence that the onset of classical adult pellagra precedes the onset of kwashiorkor by about two months.

Aetiological factors Parental neglect was illustrated by an instance of a mother's running away from home, leaving a 15-month-old girl Relatives fed the child solely on mealie-meal and she was admitted to hospital when 18 months old. This was an extreme example but there must have been many more cases not so flagrant Neglect was never admitted, however, and enquiry was difficult

Ignorance of mothercraft was a potent cause of malnutrition. Mothers frequently told me that they thought mealie-meal porridge and an occasional cup of milk were sufficient food for a child. In one instance the mother said she would not give the child milk and that it was too young for eggs, although she could supply both.

Poverty played an important part and I was frequently told that the family had no cows, or money to buy milk. I did not see a case of malnutrition in the children of the educated or wealthier Basuto

The **syndrome** varied in severity, some cases not presenting all the features of the disease The onset of oedema or diarrhoea was the sign which led the mothers to bring their children to the doctor

The average **weight** of 200 babies born in Maseru Hospital was 6 lb. 5 oz. (2 86kg) (range 4 lb 6oz to 8 lb 10oz - 1 98 to 3.91kg), which is low compared with figures for other territories given by Jelliffe[7] who points out that there is little doubt that low

birth weights are due to maternal malnutrition, manifest in this territory as adult pellagra The average weight of 28 babies born to wealthier Basuto women was 7 lb. 3 oz (3.26kg). It seems, then, that most infants in Basutoland start life at a disadvantage, but it is interesting to note that the children progress satisfactorily to the age of nine months, after which growth seems retarded. Comparison with weights of normal children shows that children who develop kwashiorkor are below standard. It is important to realize that the weights must be taken after the loss of fluid, otherwise false measurements will be obtained. Loss of weight may be considerable, two patients in this series lost 5½ lb. (2.50kg) before all signs of oedema disappeared The children usually lost about 2 lb. (0.91kg) before they started to put on weight during treatment.

Oedema in this series has been classified as (a) mild - only observed as pitting on pressure, (b) moderate - visible, restricted to the legs and (c) severe - widespread, sometimes including face and genitalia (see table).

Pyrexia (99-100°F) was present in 14 patients admitted, in 7 of whom no infection could be discovered to account for the temperature. Two cases developed pneumonia without a temperature, both being confirmed radiologically.

Diarrhoea was present in 17 cases, usually for one or two weeks before admission. The stools, three to five a day, were pale yellow, offensive and contained undigested food. The diarrhoea and undigested food are probably due to pathological changes in the pancreas resulting in defective secretion of enzymes, and to atrophic changes in the bowel interfering with digestive and absorptive functions. It seemed that the diarrhoea precipitated the onset of clinical kwashiorkor, it always preceded the onset of oedema.

Flatulence and anorexia were present in nearly all cases and were very troublesome. The abdomen was distended and tympanic, due to intestinal fermentation. Severe meteorism was encountered in eight patients, two of whom developed pneumonia - persistent distension leads to poor expansion of the lungs and renders the child very liable to pneumonia

Enlargement of the liver was not an invariable feature but was detected in 16 patients. Minor degrees of enlargement were very difficult to detect because of the accompanying distension of the abdomen The liver when palpable was tender, and smooth, with a sharp edge. With adequate treatment tenderness soon disappeared but the liver was very slow in returning to normal size.

Skin changes were seen as

(a) pigmentation (11 cases). This took the form of hyperpigmented spots, some only 1 to 2 mm in diameter and commonly found on the thighs and around the elbows Sometimes the spots coalesced, in which case they were frequently associated with peeling.

(b) fine 'crazy paving' dermatitis (11 cases), which was found on the shins and was not associated with peeling. The clinical significance is doubtful, as it had been observed in healthy children and might have been the result of the native custom of squatting cross-legged in front of fires.

Hair changes of colour and growth were the most constant feature, being observed in 22 cases. The hair was coarse, scanty and usually discoloured, tending to be grey, in one case only was there a suspicion of red colouring. These changes were usually attributed to a vitamin B deficiency, although Burn[5] attributes them to a deficiency of copper.

Radiological examination of the bowel was carried out in three cases, Passmore[9] having reported loss of the mucosal pattern in the small intestine from atrophy. No changes were observed.

Full **blood counts** of three cases (18,19,20) revealed a hypochromic anaemia, probably a simple iron deficiency anaemia due to malabsorption and inadequate intake The average haemoglobin value in 14 cases of this series was 66 per cent Sahli (=9 2g per cent) No normal levels are available for Basutoland but Squires[10] gives a value of 11.9g per cent in 100 children in Bechuanaland, and Lehmann[8] gives from 7.0 to 11.0g per cent in Uganda.

Severe liver damage was associated with defective synthesis of **plasma proteins**, aggravated by the inadequate intake of first class proteins. Low values were constantly found.

It is important to estimate the plasma proteins before treatment is instituted because the globulin fraction is already high, and added protein in the diet causes a rise in total protein by increasing the albumin fraction. Cases 10, 11, 21 and 23 showed high plasma proteins and were investigated after treatment was started measurements were Case 10 - 8 8g after 22 days, Case 11 - 9 0g after 7 days, Case 21 - 7-7g after 60 days, and Case 23 - 8 5g after 13 days.

Many values for total plasma proteins have been quoted Among healthy schoolchildren in Northern Rhodesia, Beet[4] has found an average of 6.91g, Stephen[11] on the Gold Coast gives 7.1g and Holmes[6] in Uganda, pooling the screen of 150 outpatients, gives 7 83g as the average figure. Squires[10], investigating plasma proteins in 100 schoolchildren in Bechuanaland, gives values of between 6 6 and 6.9g As Trowell[12] points out, the albumin is always lowered during an attack of kwashiorkor, but only in two cases (24 and 25) was it below 2.0g.

After treatment the plasma proteins were high and this may have been due to the high level of the globulin But the explanation put forward by Jelliffe[7] that the high globulin is the result of a chronic infection with malaria or yaws does not apply in this

territory Liver damage from a previous attack of kwashiorkor is the likely cause in Basutoland, and ten cases gave a history of previous oedema and diarrhoea. A rise in the globulin fraction is observed in other diseases of the reticulo-endothelial system (multiple myelomatosis, monocytic leukaemia, cirrhosis or carcinoma of the liver). Thus, in Case 23, the child had had an attack of kwashiorkor (diarrhoea and oedema) some three months previously, and in this case the plasma proteins were albumin 2.4g, globulin 6.1g.

Generally speaking, there was apparently no connection between the values of total proteins and severity of oedema, but this is to be expected, as, at any value below 2.6g albumin, there will be oedema irrespective of the value of total proteins. Another factor in the development of oedema may be sodium insufficiency - this may be due to low sodium intake in the diet, possibly accentuated by losses, for example, during diarrhoea

It is important to realize that when dehydration accompanies the severe diarrhoea, oedema is not necessarily present as there may be insufficient fluid This was illustrated in Case 14, who developed oedema six days after admission, when the diarrhoea had been controlled and water depletion replaced.

The normal albumin globulin ratio of 1 5 1.0 was found in only one case (21) when the estimation was done 60 days after treatment, indicating that there was no permanent damage to the liver In severe cases the ratio was reversed, and Anderson and Altmann[2] state that a persistently high globulin fraction presumably indicates permanent liver damage in the form of cirrhosis

In Case 11, who had had an untreated attack about eight months before, the plasma proteins were albumin 4.8g, globulin 4.2g Case 20 also had had an untreated attack, nine months before, after six weeks treatment the albumin was 4.3g and the globulin 3 9g Low values are shown in the table It is possible that the high globulin indicates permanent liver damage resulting from the previous attack of kwashiorkor.

All urines were examined for albumin but none was found. Excessive urobilinogen was found in 3 of 13 urines tested

Associated diseases The only manifestation of vitamin A deficiency was xerosis, seen in five patients. Vitamin B-group deficiencies were seen most frequently in the form of (a) ariboflavinosis (angular stomatitis and cheilosis), (b) hypochromotrichia (accepting it as a manifestation of vitamin B deficiency) and (c) hyperpigmentation (which I believe to be due to lack of nicotinamide). Deficiencies of vitamins C and D were not encountered

No helminthic infestation was discovered. In older age groups taenia, oxyuris and ascaris are fairly common.

(b) fine 'crazy paving' dermatitis (11 cases), which was found on the shins and was not associated with peeling. The clinical significance is doubtful, as it had been observed in healthy children and might have been the result of the native custom of squatting cross-legged in front of fires.

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The mortality rate was 19 per cent, i.e. a little lower than the rates for hospital admission 1949-51, which were kwashiorkor, 2?.4 per cent, and kwashiorkor plus avitaminosis, 23.5 per cent. A higher mortality rate was expected for those children who had experienced a previous attack of kwashiorkor, so that it is interesting to note (see table) that none of the deaths occurred among those patients.

Efforts to follow up some of the cases have been unsuccessful and it is probable that some have relapsed on returning home to the conditions which precipitated the disease

The fundamental principles in the treatment of kwashiorkor are (a) a good mixed diet including animal protein and (b) the treatment of associated diseases.

(a) *Dietary* Anorexia was obstinate and called for patience on the part of the nursing staff Milk, the main food used, soon effected a rise of plasma proteins and disappearance of oedema. There was great individual variation in tolerance of whole milk, particularly when there was atrophy of the intestines or deficiency of the pancreatic enzymes When this occurred, dried skimmed milk was well tolerated. Two pints of whole milk per day is about the maximum a child of two to three years can tolerate Very rapid improvement was noted when fresh milk was reinforced with skimmed milk, bringing the intake up to about 100g protein per day.

The daily calorie requirement for a child of one to three years is in the region of 1,200 Calories which, although probably rather high, is obviously desirable Two pints (1 14 litres) of milk supply only 680 Calories. Again, the daily protein requirement is in the region of 40g, and two pints of milk supply only 36g. As kwashiorkor is a hypoproteinaemic state, 70 to 120g animal protein should be given daily It is better to put the child on to an adequate mixed diet as an example for the mother to follow, rather than to rely on protein concentrates and skimmed milk, which the mother might find hard to obtain The diet customarily used in treatment includes 4 oz (113g) beef, 1 egg, 2 oz liver, 2 pints milk, 2 oz. bread, 4 oz potatoes and some vegetables, this provides 83g protein. Vegetable protein is apparently of some value as the incidence of kwashiorkor is less frequent when vegetables (melons, pumpkins, spinach and cabbage) become available (see page 241). In the uncomplicated case, improvement was evident in four to five days Persistent distention of the abdomen was treated with enemata on alternate days

(b) *Associated diseases* were treated on general lines. Penicillin was the drug of choice for pneumonia, and supplementary iron [iron ammonium citrate 15 grains (0 97 grams) per day] was used to treat anaemia The standard diet supplies a considerable quantity of iron (14mg per day).

Infections encountered as complications are detailed in the table, it will be noted that there was no malaria. The positive Wassermanns represent an incidence of 15 per cent (only 13 sera were examined), and compare favourably with an incidence of 23 per cent positives from 153 mothers attending the ante-natal clinic.

Autopsy findings Consent for autopsy was difficult to obtain and, of the five patients who died, permission was granted in two instances only

Case 13, age 11 months, who had been weaned at four months and thereafter had received only mealie-meal porridge, died three days after admission The liver was smooth yellow and fatty The pancreas was small There was atrophy (typical of kwashiorkor) of the whole of the small intestine and the wall of the intestine appeared almost translucent Histological examination showed diffuse and extensive fatty change of the liver but no pathological change in the pancreas, which is unusual as this commonly precedes changes in the liver

Case 26, age 3½ years, who had had severe oedema including the face and scalp died four days after admission She had been removed from the breast ten months before and had been fed on mealie-meal and kaffir corn porridge Clinically the case was typical of kwashiorkor but complicated by ariboflavinosis and bilateral broncho-pneumonia The liver was palpable one finger-breadth below the costal margin

At autopsy, there was a diffuse broncho-pneumonia and a small quantity of fluid in both pleural cavities The liver was enlarged, smooth and fatty with 'islets' of fat visible on the surface It felt 'gritty' when cut and the cut surface showed peripheral fatty changes in the lobules The pancreas appeared normal The mucous membrane of the small intestine showed loss of pattern but there was no atrophy of the intestinal wall Histological examination showed a well-marked fatty change in the liver Portal tracts showed a slight increase in fibrous tissue and very slight round cell infiltration There was slight interstitial fibrosis of the pancreas but no change in the small intestine

The **prognosis** is difficult to assess and is, in the main, determined by the severity of concurrent infections. Thus, three of the five deaths were due to pneumonia, this being the commonest complication.

It is doubtful whether the duration of the disease is of much importance as the children are usually brought to the doctor within one or two weeks of the onset, and deaths did not occur in those cases who had suffered from previous attacks

There remain the cases (13 and 16) with no serious complication, who in spite of adequate treatment failed to improve It is in this type of case that severe atrophic changes occur in the bowel, as found at autopsy in Case 13, with gross dysfunction of the digestive and absorptive processes, leading to persistent diarrhoea, and anorexia Such changes are irreversible and the prognosis is grave from the beginning

kwashiorkor is infantile pellagra and its causative factor is to be found in whole maize.

Summary

The aetiology, clinical findings, pathology, prognosis and treatment of 28 cases of kwashiorkor in Basutoland are described.

Attention is drawn to the age incidence, the seasonal incidence and its close parallel with the seasonal incidence of pellagra in that territory.

Autopsy findings in fatal cases are given and the changes in plasma protein in ten cases given in detail, and the significance of the changes, particularly in the plasma globulin, is discussed.

The clinical findings are given in detail and the frequency of associated vitamin B deficiencies emphasized. The importance of concurrent infections is stressed, as is the fact that pneumonia accounted for three out of the five deaths. It is interesting to note that previous attacks did not influence the prognosis. Helminthic infestations and malaria were not encountered.

The importance of a high animal protein diet is stressed, a diet supplying 83g protein used for treating kwashiorkor is given. The writer believes it is important to give a mixed diet which serves as an example for the mother to follow on return home rather than protein concentrates alone.

The possible causes of kwashiorkor are discussed and the suggestion is made that kwashiorkor is infantile pellagra, the causative factor of which is to be found in whole maize

My thanks are due to the Acting Director of Medical Services, Basutoland, for permission to publish, to Dr B. D. Whitworth for his help and advice, to the Superintendent, South African Institute of Medical Research, Bloemfontein, for plasma protein estimations, and to sisters and nurses in treating the cases.

The vitamin B-complex deficiencies were corrected by the addition of dried food yeast to the diet (see reference 1)

The importance of maintaining an adequate diet on returning home was stressed, although this was frequently impossible. However, the mother who stayed in hospital with the patient had had the opportunity of seeing what kind of food the child should eat to prevent recurrence.

Discussion

The cause of kwashiorkor is still unknown but two main explanations have been advanced (a) that it is a lack of vitamin B-complex and (b) that it is an inadequate protein intake. When considering this series of cases there is much evidence to support the first of these hypotheses. Kwashiorkor occurs in the same areas, the Northern lowlands, in which pellagra is found in a large number of people, and follows very closely the seasonal incidence of pellagra Manifestations of vitamin B deficiencies such as ariboflavinosis and hyperpigmentation are commonly seen, though the distribution of the dermatitis does not resemble that seen in classical pellagra. Diarrhoea, a constant feature in kwashiorkor, is also seen in severe pellagra. Kwashiorkor, however, does not respond to vitamin B therapy alone and it is found in other parts of the world where pellagra is uncommon.

In all the 26 cases described the protein intake was inadequate and response to treatment was unsatisfactory unless large amounts of animal protein were given. It is possible, of course, that vitamin B deficiencies are the result of intestinal atrophy, following hypoproteinaemia, but no deficiencies of vitamins A or C were observed such as would be expected if vitamin absorption had been impaired

There is no doubt that maize plays an important role in the aetiology of both kwashiorkor and pellagra Mealie-meal was the main constituent of the diets and in 14 cases the only item It may be that there is a toxic factor in the whole grain of maize, and the increased number of hammer-mills in Basutoland supports this view. Foods containing animal proteins, particularly tryptophan, protect against kwashiorkor Tryptophan is converted into nicotinamide in the animal body and is therefore the precursor of the pellagra preventing vitamin The absence of kwashiorkor in the mountain areas where wheat is eaten, and little or no maize, points to maize being the responsible factor It may be that the toxic factor in maize, if it exists, produces in the liver fatty changes which interfere with the synthesis of the plasma proteins, or that the absence of the lipotropic amino-acids initiates the fatty changes in the liver

There is such a close correlation between pellagra and kwashiorkor in Basutoland that I believe they are the same disease, that

REFERENCES

1 Accessory Food Factors Committee *(1945) Food Yeast har Memorandum med Res Coun ,Lond , No 16*

2 Anderson, C. G & Altmann, A *(1951) Lancet, 1, 203*

3 Annual Medical & Public Health Report, Basutoland *(1949) p 5*

4 Beet, E. A *(1951) Arch Dis Childh , 26, 119*

5 Burn, J H *(1951) Brit J Derm.* 63, *431*

6 Holmes, E G , Stanier, M W , Semambo, Y B. & Jones, E R *(1951) Trans R Soc trop Med Hyg* 45, *371*

7 Jelliffe, D B *(1952) Trans R Soc trop Med Hyg , 46, 13*

8 Lehmann, H. *(1949) Lancet,* 1, *90*

9 Passmore, R *(1947) Trans R Soc trop Med Hyg* 41, *189*

10 Squires, B T *(1949) The Feeding and Health of African School Children, Sch Afr Studies No 20, University Press Capetown*

11 Stephen, T D *(1948) Trans R Soc trop Med hyg* , 41, *829*

12 Trowell, H C *(1949) Trans R Soc trop Med Hyg* , 42, *417*

Clinical findings in 26 cases of kwashiorkor

Case no	Sex	Age (years)	Hb %	Plasma protein: Total	Plasma protein: Albumin	Plasma protein: Globulin	Weight on admission: lb	Weight on admission: kg	Weight after loss of oedema: lb	Weight after loss of oedema: kg	Complications	Severity of oedema	Liver palpable	Previous attack	Days in hospital
1	F	6					27	12 2				+			41
2	M	3	76				36½	16 4			R	+++	*	*	17
3	F	1½					14	6 4			R P	+		*	41
4	F	4	70				21	9 5			O P	+			18
5	M	3					26	11 8	24½	11 1	B	++			13
6	M	2					24¾	11 2	19¼	8 7	R	+++	*	*	21
7	M	3					26½	12 0	24¾	11 2		++			20
8	M	3					26½	12 0	24¾	11 2		++			21
9	M	3					21	9 5	19	8 6	I	+++	*		28
10	F	2		8 8			19¾	9 0	15¼	6 9		+++	*	*	28
11	F	3		9 0	4 8	4 2	26½	12 0	24¼	11 1	P	++	*	*	17
12	F	3½	74				22	10 0	21½	9 8	B S	++	*		52
13	M	11/12					11	5 0			B O	+++			died
14	M	11/12					11½	5 2			P	+			died
15	F	2	80				16	7 3	15½	7 0		+++	*		48
16	M	2½	58	5 3	2 6	2 7	22	10 0	20	9 1		++	*		died
17	M	2	70	5 8	2 7	3 1	23½	10 7	18	8 2	P	+++			died
18	F	1 10/12	77	3 6			24¾	11 2	20¾	9 4	R	+++	*		29
19	F	3	68	6 8			14	6 4			B	+	*	*	38
20	M	4	60	4 3	2 0	2 3	30	13 6	27	12 2	R	+++	*	*	44
21	M	1½		7 7	4 4	3 0	15	6 8	14	6 4	R B	+	*	*	93
22	M	3	76	6 3	3 3	3 0	22¾	10 3	18½	8 4	R P S	+++	*	*	55
23	M	1 4/12	60	8 5	2 4	6 1	14	6 4	13½	6 1		+	*	*	33
24	F	1 10/12	60	4 8	1 7	3 1	17	7 7	16½	7 5	R P	+++	*		33
25	M	1	60	6 0	1 7	4 3	15	6 8	14½	6 6	B P I	+			36
26	F	3½	64	5 3	2 1	3 2	15½	7 0			P	+++	*		died

Complications
R rhinitis
O otitis media
B bronchitis
P pneumonia
S stomatitis
I impetigo

Oedema
+ mild
++ moderate
+++ severe

REFERENCES

1 Accessory Food Factors Committee (1945) *Food Yeast, War Memorandum Med Res Coun, Lond, No 16*

2 Anderson, C. G. & Altmann, A. (1951) *Lancet*, I, 203

3 Annual Medical & Public Health Report, Basutoland (1949) *p 5*

4 Beet, E A. (1951) *Arch Dis Childh*, 26, 119

5 Burn, J H. (1951) *Brit J Derm* 63, 431

6 Holmes, E G., Stanier, M W., Semambo, Y. B. & Jones, E R. (1951) *Trans R Soc trop Med Hyg*, 45, 371

7 Jolliffe, D B (1952) *Trans R Soc trop Med Hyg* 46, 13

8 Lehmann, H. (1949) *Lancet*, I, 90

9 Passmore, R (1947) *Trans R Soc trop Med Hyg*, 41, 189

10 Squires, B T (1949) *The Feeding and Health of African School Children, Sch Afr Studies No 20, University Press, Capetown*

11 Stephen, T D (1948) *Trans R Soc trop Med Hyg*, 41, 829

12 Trowell, H C (1949) *Trans R Soc trop Med Hyg* 42, 417

MALNUTRITION IN THE BECHUANALAND PROTECTORATE

by

B T Squires

The Bechuanaland Protectorate lies between 18° and 27° S latitude and between 21° and 28° E longitude, and the area is about 275,000 sq miles (71 million hectares) Over nearly all the Protectorate the chief sources of water during most years are wells dug in river beds and valleys The shortage of water is proverbial, even apart from drought seasons which occur with distressing frequency

Available **rainfall** figures cover a relatively short period, most of the rain falls between October and April, usually in heavy storms of short duration The mean annual rainfall for the whole territory is between 15 and 20 inches (38 to 51 cm) In the Kalahari there is no 'run off', but elsewhere much of the water is rapidly drained away by the torrent beds leading to the big rivers Such storms, especially the early ones, tend to be very localized This tendency affects agriculture adversely for, after the dry winter and spring, the soil is so hard that it cannot be ploughed until the first rains have fallen

Absence of early rains means a postponement of ploughing, and this in turn may mean that the crops will not mature in time to escape the first frosts, which occur usually towards the end of May In general, the rainfall is so irregular and undependable that good harvests are reaped only once every four or five years

The **soil** consists of sandy loams, interspersed with black clays Its distribution is very irregular, with the result that patches of land suitable for cultivation are scattered among sand belts and outcrops of rock

Vegetation, in spite of the scanty rainfall, is not insignificant The land in the east is rich in trees, shrubs and grasses, and the growth of thick bush is widespread, chiefly acacia type (especially *Acacia karoo*) in the south and 'mopane' (*Copaifera mopane*) in the north The grasses provide good grazing for cattle and other animals, and in years of good rainfall wild fruit and vegetables are plentiful and help to augment food supplies

The **population** is about 290,000 and the distribution is very uneven, for the waterless wastes of the central and southern Kalahari are inhabited by only a few thousand people living in scattered communities the majority live in the eastern districts, in the favourable areas along the Botletle river, and in the Okavango basin

The original inhabitants of the Protectorate seem to have been the Sarwa, a primitive people of bushman stock, who lived in small

independent co-unities a d were essentially hunters At an unknown date they were followed by the Kgalagadi, who are of Tswana stock but are more primitive than the other Tswana tribes which entered Bechuanaland, chiefly from the north-east, about the beginning of the 18th century These latecomers, in contrast with their predecessors, were primarily pastoral and agricultural people, although hunting played a great part in their economy The people are still pre-eminently pastoral, since the uncertain rainfall limits agriculture

It is the custom of the larger Tswana tribes to live in comparatively large communities, amounting in the case of the chief towns of the big reserves to 25,000 or more The original reason for this probably had to do with facilities for defence and ease of administration This custom, together with difficulties due to widespread dispersal of arable land, of pasture and of water, has compelled the Tswana to evolve a territorial organization which differs from that of every other Bantu tribe in South Africa and affects their nutritional problems Only a favoured few are able to have their arable lands near the settlements, most of the lands are dispersed in more or less continuous blocks far across the country, so that many families have to travel up to 40 miles to their holdings

The cattle, which have always been the chief source of Tswana wealth, cannot be kept on the arable lands, so are sent out to far distant cattle-posts, whose location depends upon the amount of pasture and water available Few of the posts are near the main villages, some being as far as 100 miles away It will be seen, therefore, that the supply of milk presents difficulties in the large settlements This scarcity of milk was noted many years ago by Anderson[1] and Jagdowski[3]

The people live in the villages only between the completion of the harvest in June or July and the start of the rainy season in October or November As soon as the rains have begun, the majority of the inhabitants leave for their lands, whence they do not, in a good year, return until after the harvest is reaped, although during this period there is a continual coming and going of individuals between the lands and villages where they stay for a few days at a time to obtain supplies, attend tribal meetings, etc The only people left in the villages are the aged and, nowadays, the majority of such children as attend school In addition to the seasonal migration, part of the population, chiefly boys, is permanently dispersed at the cattle-posts, for Tswana custom decrees that the care of the cattle shall be the duty of the boys and young men

It is necessary to consider the effects upon the Tswana of European influence, which has had an important bearing on nutritional problems So far as this particular aspect is concerned, the most important changes are those relating to hunting, agriculture, labour migration and education

The increasing use of firearms of the modern steel trap and, to a lesser degree, of the horse, made hunting easier but resulted

in the game's being driven further afield it is, therefore, more difficult to obtain and the supply of meat from this source has been greatly lessened

There has been no occupation of arable land in the Protectorate by Europeans comparable with that which has taken place in other parts of South Africa so the amount available for cultivation has not altered much on this account

The replacement of the primitive hoe by the plough has tended to improve agricultural yields, although at the same time the area available for **cultivation** has been restricted The reason for this apparent paradox is that the draught oxen used for ploughing must be within reasonable distance of watering facilities, which are not available in all areas Further, a man may not be sufficiently prosperous to possess enough oxen to make up a team so that he has to make arrangements to borrow oxen in return for labour Should he have difficulty in borrowing enough oxen to be able to plough at the right time, his crops may be adversely affected

For many years past, it has been the custom for men seeking new **sources of income** to leave the Protectorate in order to work outside and as many as 40 per cent of the able-bodied men of a reserve may be away at one time The majority of these adventurers find employment at the Witwatersrand gold mines

Since **labour migration** is not dependent upon education, it is possible for the poorest and most illiterate to earn money wherewith to purchase trade goods and to increase the standard of living Labour migration, however, undoubtedly tends to affect adversely the old tribal system and to render difficult the maintenance of tribal discipline Through the absence of so many able-bodied men, agriculture is affected for the women are in many cases unable or unwilling to plough and cultivate their lands properly, and consequently tend to buy their cereal food in the form of machine-milled meal or flour from the traders

The introduction of **education** has influenced the pattern of Tswana child life, for, whereas formerly children who were not at the cattle posts accompanied their parents to the lands during the season, they now stay in the village These children are either under the care of relations who for some reason or other (usually age) have not taken part in the general migration, or else they club together in a communal group to fend for themselves The effect of this departure from tribal custom upon nutritional status can be very deleterious Further, it has been alleged that corn may be lost as children at school are unable to exercise their traditional function as bird scarers whilst the crops are ripening

The **staple food** of the Tswana consists of Kaffir corn (*Sorghum* spp) and to a lesser extent, mealies, supplemented as opportunity occurs by meat vegetables, fruit, milk and last but by no means

least, kaffir beer A detailed account of the preparation and preservation of food, varieties of dishes prepared and the cooking thereof has been given elsewhere[6]

Relation between production and food cycles The way in which available foodstuffs can vary in years of good rainfall is shown in the table, which demonstrates the correlation between production and food cycles The season begins in October, just before ploughing commences It is assumed that the year under consideration and the previous year both enjoyed good rains

Production and food cycles

Month	Production cycle	Food cycle
October	All people at home	A little rain towards end of month Plenty of last season's grain, mealies, beans, sweet reed and dried melon No milk Plenty of beer
November	Towards end of month people begin to migrate to lands	Rain increasing Plenty of last season's crops available Wild fruit, berries and spinach now ripening No milk Plenty of beer
December	People now ploughing	Plenty of rain Still a sufficiency of last season's crops Wild fruit, berries and spinach now available Milk brought in from cattle-posts
January	Last fields ploughed and crops planted	Plenty of rain Previous season's store of crops becoming low Fruit, etc , still plentiful Plenty of milk
February	Weeding in progress	Plenty of rain Previous season's store of grain becoming low Fruit, etc , still plentiful Milk abundant
March	Most crops now up, and weeding in progress	Still plenty of rain Fruit, etc , becoming scarce Melons and green mealies becoming available Milk still plentiful

Production and food cycles (continued)

Month	Production cycle	Food cycle
April	Weeding in progress	Rain ceasing Last year's grain finished Beans, melons, mealies and sweet reed now ripening Milk still plentiful
May	People occupied in bird scaring and preparing threshing floors	End of rains No fruit Green vegetables plentiful Some mealies ripe Milk becoming scarce
June	Fallen corn now collected Harvest begins threshing floors prepared	No rain water becoming scarce Green vegetables finished but plenty of melons, mealies and beans No milk
July	Reaping in full swing	No rain water scarce Melons, mealies, corn and beans plentiful No milk
August	Threshing in full swing	No rain A few green melons plenty of dried melons, corn, beans and mealies No milk Plenty of beer
September	People now return to settlements	No rain Plent of corn, mealies and dried melons No milk Plenty of beer

It can be seen from the table that in good years there is an abundance and variety of food Unfortunately good harvests are infrequent, one in about four to five years, so that in most years cereals have to be imported to make up the shortage

The incidence of nutritional deficiency varies greatly, as would be expected not only from one year to another but also from one region to another Figures extracted from annual medical reports over the last 20 years give a mean incidence of deficiency diseases of about 2 per cent of all patients seen, but such figures reflect the incidence of serious cases only further, the number of medical stations is very small in relation to the size of the territory

Figures from field surveys using criteria described elsewhere[6] show the incidence to be greatest in the large settlements, where surveys of school children have given an incidence of 20 to 30 per cent, rising in one locality during the drought year of 1944-5 to 90 per cent[6] In the smaller communities, where it is easier to get milk and to augment the basic diet of cereal with wild fruit, vegetables, roots, small game, etc , the incidence is much less, dropping in the case of the Sarwa community to 3 per cent[5] For pre-school children and sucklings, figures can only be obtained from out-patient and hospital registers In an unselected series from one centre, where the figures were extracted from entries over a period of two years, the proportion diagnosed as suffering from nutritional deficiency was 13 per cent of all child patients examined

Severe cases of undernutrition due to prolonged lack of calories and protein are rarely seen but milder cases are commonly encountered Most cases are due to lack of vitamins and minerals and are of all degrees of severity

Examples of the classical deficiency diseases are rare compared with those of mixed deficiencies The manifestations and symptoms include dyspnoea upon exertion, cough, palpitations, vague pains in joints and musculature, gingival bleeding, varying degrees of nyctalopia, corneal ulceration, xerophthalmia, conjunctival furrowing, angular stomatitis, glossitis, koilonychia, hypochromotrichia, oedema of ankles, hypochromic microcytic anaemia, and skin affections such as 'crazy pavement', phrynoderma, dyssebacia and a scaly dermatitis which has been described elsewhere[4]

Kwashiorkor has not yet, to the writer's knowledge, been diagnosed as such in the territory, although its constituent characteristics, e g oedema and hair changes, are encountered singly

In adults the commonest symptom is vague muscular pain, with 'crazy pavement' skin markings on the face, but there is also a multitude of ill-defined signs For example, in the winter, wounds do not heal well or quickly, surgical incisions become infected more frequently, and abortions and miscarriages tend to be prolonged and to require intervention more often than at other seasons It has been found empirically that many of these complications, and others, can be avoided in hospital cases by putting such patients upon admission on to a diet fortified by the addition of ascorbic acid and yeast powder

Finally, it is worth noting that many of the more intelligent Tswana mothers are well acquainted with certain of the signs and symptoms given above and know them to be due to nutritional deficiency

Malnutrition in relation to helminthic and parasitic disease Apart from schistosomiasis, which is very common along the Limpopo river (the boundary between the Protectorate and the Transvaal),

Production and food cycles (continued)

Month	Production cycle	Food cycle
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May	People occupied in bird scaring and preparing threshing floors	End of rains No fruit Green vegetables plentiful Some mealies ripe Milk becoming scarce
June	Fallen corn now collected Harvest begins threshing floors prepared	No rain, water becoming scarce Green vegetables finished but plenty of melons, mealies and beans No milk
July	Reaping in full swing	No rain, water scarce Melons, mealies, corn and beans plentiful No milk
August	Threshing in full swing	No rain A few green melons, plenty of dried melons, corn, beans and mealies No milk Plenty of beer
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Available data show the incidence of malnutrition to be very variable, among children of school age, 20 to 30 per cent of all subjects examined in the large communities were diagnosed as being malnourished in the smaller communities the figure was as low as 3 per cent

During one drought year, the proportion of children showing signs of malnutrition rose to 90 per cent in one large settlement

Figures for sucklings and children of pre-school age are limited, but in one centre 13 per cent of such patients were diagnosed as suffering from malnutrition

Acknowledgement is made to the Bechuanaland Protectorate Government for permission to quote figures from departmental reports and to make use of unpublished findings

REFERENCES

1 Anderson, A A (1887) *Twenty-five Years in a Waggon in the Gold Regions of Africa* Chapman & Hall, London

2 di Palma, J R (1946) *Arch intern Med* 78, 405

3 Jagdowski, B Z (1885) *Further correspondence regarding the Affairs of the Transvaal and Adjacent Territories* Colonial Office C4588 Eyre & Spottiswoode, London

4 Squires, B T (1941) *S Afr med J* , 15, 449

5 Squires, B T (1943) *Afr Stud* , 2, 4, 210

6 Squires, B T (1949) *Sch Afr Studies* No 20, *University Press Capetown*

helminthic infestation is not common, the incidence according to medical returns being about 1 to 2 per cent of all patients seen over the last ten years, in an unselected sample of 381 school children 7 per cent only were found to be infested So far as investigation has been made, apart from these areas there seems to be no connection between helminthic disease and malnutrition

The most important parasitic disease is malaria which is endemic throughout the northern part of the Protectorate Even so, out of a sample of 200 children from northern settlements (none of which is very large) in the Chobe area, of whom 42 per cent exhibited varying degrees of splenic enlargement, only 5 per cent showed stigmata of malnutrition

Comment

The picture, then, is one of intermittent malnutrition rather than undernutrition, it varies in severity from year to year and from one locality to another

Although malnutrition may not appear to be severe in any one year, the cumulative effects may be dire It has been noted by personal observation of the same groups of subjects over several years that the average Tswana child can weather one bad season, or even two, and yet recover, but that further bad seasons tend to push a proportion of them so far down the slopes to the Avernus of chronic malnutrition that they tend to become easy victims of infection In this connection it may be remarked that the use of tongue prints taken by a modification of the method of di Palma[2] and employed as a permanent record, has proved very useful in following the developments of the nutritional patterns of such children

Finally, sucklings, so long as they are not completely weaned, do surprisingly well in bad seasons and in many cases much better than their elder brothers and sisters

Summary

An account is given of malnutrition in the Bechuanaland Protectorate

Geographical, topographical, climatic and sociological factors are briefly described

Severe undernutrition due to prolonged lack of calories and protein is rare, but milder cases are not uncommon, no case of kwashiorkor has yet been reported

Deficiencies commonly encountered are due to lack of vitamins and minerals and are intermittent, varying greatly in severity from year to year and from one locality to another

(11926)

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2 di Palma, J R *(1946) Arch intern Med* , 78, *405*

3 Jagdowski, B Z *(1885) Further correspondence regarding the Affairs of the Transvaal and Adjacent Territories Colonial Office C4588 Eyre & Spottiswoode, London*

4 Squires, B T *(1941) S Afr med J* , 15, *449*

5 Squires, B T *(1943) Afr Stud* , 2, *4, 210*

6 Squires, B T *(1949) Sch Afr Studies* No 20, *University Press, Capetown*

REVIEW OF NUTRITIONAL RESEARCH AND SURVEYS IN NIGERIA

by

Davidson Nicol

The Nigerian Government has always been alive to the importance of nutritional problems Over the past 20 years there have been medical workers in the field, such as McCulloch, Turner, and Hughes, and latterly nutrition officers such as Ellis and Cull More recently, concentrated work has been done in Bida in the north and Warri in the west by Nicol[8] and also by Medical Field Units, especially in the north, under McLetchie[7] The whole country has not yet been systematically covered and there is obviously a variety in feeding habits and deficiency manifestations in a country of about 400,000 square miles (7,036,000 sq km) with a population of about 30,000,000 With decentralization of the medical services to a regional basis - North, West and East - nutrition surveys might be made administratively less difficult The Central Government proposes to appoint an Adviser in Nutrition and this would mean co-ordination and more ystematic work.

It was decided to do a general pilot survey of the rest of the Western Region (that is, omitting Warri) to determine the obvious signs associated with malnutrition, to put them in a less conjectural form, and to create a basis for future work to be undertaken in a typical western village in the wake of the December census

The Western Region extends from Abeokuta Province on the French Dahomey border to Benin on the banks of the Niger and from the Oyo - Ilorin border in the North to the Atlantic Coast The population consists mainly of the Yoruba nation and smaller groups such as the Binis Kukurukus and Ibos The main occupations are farming and trading The diet of the Western Region is dealt with on page 262

District Medical Headquarters and those of Medical Field Units were visited individually for several days, and the town and surrounding villages were then visited School children and some adults were examined Most of the women seen were pregnant Two prisons were visited and some short-term male prisoners seen The majority of the cases seen, however, were children Out of a total of 316 cases, 200 were under the age of 14 It was felt that it would be advisable to concentrate on this group, where measures for definite improvement could be undertaken The children were usually selected from infant and primary schools by a non-medical person

Signs were only marked down as positive when definite, and comparison was constantly made to one standard set of photographs showing nutritional deficiency signs

In each town visited cases of kwashiorkor were looked for in Government admission hospitals These cases were almost invariably found in the children's ward and showed the classical signs of

oedema, apathy, dermatosis, diarrhoea, and hypochromotrichia They were being treated by dieting, and with vitamin concentrates and vermifuges

Some rural medical work was also undertaken to get an idea of the extent of nutritional deficiency signs in cases of definite illness, although these were not included in the survey Patients of the lowest social status and those who suffered from tropical ulcers and yaws showed the most signs of malnutrition

Eye disturbances such as photophobia, night blindness and lachrymation were common It should be remembered, though, that these are more symptoms than signs and so could not be definitely verified Hyperaemia and excess tissue in the conjunctiva were also frequently found These, especially hyperaemia, were said to be due to chronic irritation from smoke, as reading or vision at night is often by oil lamps in a closed room, and cooking is done over a smoky wood fire, but taken in conjunction with the photophobia, lachrymation and dimness of vision, it is more likely that the eye signs are due to riboflavin deficiency There is a marked absence of blepharitis, pigmentation, xerophthalmia and cataract, which are common in the Northern Region of Nigeria where food shortages are more severe

In general, the **dental condition** of the children was poor, except where they were under active medical supervision

The percentage of swollen, hyperaemic and bleeding gums was noticeably high, especially in school children One of the causes of these signs is lack of ascorbic acid, and it would be difficult to understand how this could be so in the tropics if one were not aware of the fact that children are discouraged from eating fruit on the grounds that it causes worms A small percentage of the gingival lesions may be due to pyorrhoea It seems likely, however, that in the majority of cases, the bleeding of the gums on pressure was due to riboflavin deficiency, since the incidence of this approximates closely to that of angular stomatitis and cheilosis

The **tongue** and **lips** showed signs of definite deficiency of riboflavin There were only a few cases of hypertrophic papillae In most cases the tongue was smooth and sore and in about one-third of the cases the tongue was red

The widespread incidence of **angular stomatitis** was confirmed It was more prevalent among school children, (50 per cent of all cases were in the age group 10 to 14 years) This sign varied from slight fissuring at the corners of the mouth to noticeable ulceration Where visible, it reached the point of a moist white fissure and was listed as la perleche, this was so in about one-third of the cases which showed this sign

Cheilosis, usually found in the lower lip as scaliness and fissuring and sometimes as swelling and reddening, seemed to be present in most of the cases with la perleche The pilot survey was done during the rainy season During the windy season and the harmattan and at times during the dry season, chapped lips and an inclination towards cheilosis were more evident

A clinical degree of **anaemia** was found in one-third of the cases

In very few cases was the **skin** unblemished It was usually dry and crackled, especially over the shins, this occurred mostly in school children A lower percentage, also mostly among children, showed follicular keratosis chiefly on the back of the forearm and on the thigh

Nearly all showed on their legs scars more than 1 cm in diameter The cases of septic conditions seen were mostly chronic infected leg ulcers and these were usually in the more malnourished children

Intestinal **parasitic infestation** is endemic in the Region and its nature varies from district to district It can be a causative factor in iron deficiency anaemias and general malnutrition Its extent was estimated by direct questioning which gives only a general indication

The whole of Nigeria is malarious but this Region is hyper-endemic The mean crude parasite rate (all species) is between 20 and 50 per cent for the adolescent group, the majority of the infections being due to *Plasmodium falciparum*[3]

There are endemic foci of other infections, for example, the guinea-worm in Ijebu Ode district and bilharzia in Igarra near the left bank of the Niger-Benue junction

The calculated **daily nutrient intake** of a group the Illu farmers, which may be taken as representative of the average rural community in the region can be compared with that recommended by the Food and Nutrition Board National Research Council, for the physically active (in brackets) -

Calories 2 252 (3 000) Protein animal 17g, vegetable 26g, total 43g (70g)

Fat	43g		Carbohydrate	424g	
Vitamin A	7 348 i u	(5 000 i u)	Thiamine	0 69mg	(1 5mg)
Riboflavin	0 65mg	(1 5mg)	Nicotinic acid	8 9mg	(15mg)
Ascorbic acid	30mg	(75mg)	Calcium	664mg	(1 000mg)
Iron	21mg	(12 to 15mg)			

There is a deficiency of vitamins B and C calcium and first class (animal) protein in the Western Region These deficiencies are more pronounced in the young because of the demands of growth on the system and simply because they have less to eat

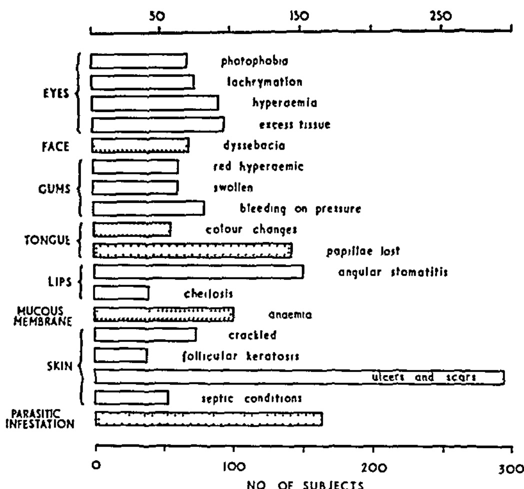


Fig Incidence of some signs associated with malnutrition in 316 subjects examined in the Western Provinces, Nigeria, July to October, 1952

The calorie intake is lower than the optimum and is chiefly made up from carbohydrate sources such as garri and yam

Protein deficiency shows itself in loss of weight, lowered resistance to states of stress such as pregnancy, lactation and illness, and in anaemia

The greatest mean weights are reached by populations eating most animal protein For example, the women of the Soragbemi fisherfolk who have a lower calorie intake than those of the Illu but a higher animal protein intake, have a greater mean weight during the child-bearing years, and infant mortality is lower

In Western Nigeria the average birth weight has been found to be lower than the average for the country, being about 6½ lb (3 kg)[10] Although the reason for this may be partly nutritional,

it seems to be due more to the early age of maternity and the size of the African pelvis, the general smallness of which is not due to rickets or osteomalacia

Anaemia of pregnancy is common and is sometimes extreme[11] The diet of the poorer Yoruba expectant mother consists largely of carbohydrate, palm oil and vegetable protein, and the quantity intake of these is also low It is suggested that one result of this maternal malnutrition is fatty infiltration of the liver in new-born babies The histological picture is similar to that found in classical malignant malnutrition occurring in older children after weaning; typical examples have been described elsewhere[9] The suggestion is made that malignant malnutrition in infants may begin during intra-uterine life, due to the malnourishment of the pregnant mother

Jelliffe[5] has reported the results of analyses for protein content of specimens of breast milk from nursing mothers An average of 1 04 per cent (0 59 to 1 76 per cent) was found As is well known lactation continues for one to 36 months, yet there does not seem to be a decrease in protein content with length of lactation Considering that the animal protein intake of the mother was about 10 per cent or less of the recommended intake of total protein, this figure for milk protein is favourably high The diminishing total quantity of the milk as lactation proceeds, and possibly the quality of the protein, may contribute to the genesis of kwashiorkor

Another manifestation of malnutrition in children seen in Ibadan, Western Nigeria is oral disease[6] which may be due to protein deficiency It occurs at about the third year, when the child has just been weaned, and usually during the hungry season (May to July) A prolonged period of malnutrition is followed by Vincent's gingivitis which is very common This may progress to infection of the mandible and maxilla by spreading through the roots of the teeth A steady march onwards results in involvement of the adjacent soft tissues by direct contact, producing gangrene of the inner surface of the cheeks, which rapidly advances peripherally Treatment is by a high protein diet, penicillin and, where possible, plastic repair

A high proportion of the symptoms and signs is due to the lack of riboflavin Those which are prominent are hyperaemia of the conjunctiva, dyssebacia colour changes and lost papillae in the tongue, and angular stomatitis Photophobia, lachrymation swollen and bleeding gums may partly be due to the lack of riboflavin It is usually safe to assume that lack of one member of the vitamin B-group implies deficiency of all the others The vitamin B-group is present in meat, liver and eggs These are foodstuffs which are notoriously absent from the diet of the majority of the Nigerian population mainly through poverty, and this leads to a deficiency not only of vitamins but also of protein and amino-acids

If night blindness and follicular hyperkeratosis are classical manifestations of vitamin A deficiency, it is difficult to explain

their presence in Western Nigeria where sufficient vitamin A is available It may be, of course, that the carotene in red palm oil - the chief source of vitamin A - has not been completely available to the subjects or that deprivation of vitamin A is not the chief causal factor[4], and that some other cause of these manifestations must be looked for

Improvement in the nutritional status of a people involves changes in the social and economic factors With children there is a definite opportunity presented, especially as compulsory education is envisaged in this Region Before discussing how this could be done, attention must be focused first on infants and those of pre-school age between one and five years It is in this group that the condition known as Kwashiorkor or malignant malnutrition occurs Brock and Autret in their WHO monograph[2] have dealt with all the known aspects of this disease in Africa Briefly it is characterized by retardation of growth between one and five years of age, dyspigmentation of the hair, oedema with hypo-albuminaemia (the swelling is marked in the extremities), liver changes, skin disorders, gastro-intestinal upsets such as diarrhoea, peevishness and mental apathy, and a heavy mortality if untreated or improperly treated In every hospital visited in this Region several cases of Kwashiorkor were being admitted monthly These are bound to be only a percentage of those affected Sometimes the disease has a slow genesis At other times it is precipitated rapidly by infection or heavy parasitic infestation in an apparently healthy child In most cases it was being treated by milk and vitamin B concentrates, and the infection or parasitic disease was also being attended to The treatment now recommended is to search for any infection and treat it provided that in the case of malaria, treatment is gradual and not in full dosage milk protein in the form of skimmed milk is given immediately - children in the severe stages tolerate poorly the fat of whole milk a suitably varied diet is gradually introduced In very severe cases human plasma is introduced slowly intravenously or into the bone marrow or subcutaneously for the first ten days Adams[1] has produced astonishing clinical improvements and a rapid return of gross liver changes to normal with 'Hepanino'*, a predigested preparation of whole liver

Preventive measures which will assist in lowering the incidence of this highly preventable and often fatal condition are active supervision in infant welfare clinics of children beyond eighteen months up to the age of five when they enter school, active propaganda for a mixed infant diet in these clinics and in all village and town dispensaries and hospital out-patient departments In the larger towns - such as Ijebu Ode - instructions of this nature are sometimes given, but this is not done in the smaller places

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* Evans Medical Supplies Ltd London

Ijebu Ode Infant Welfare Clinic

Diet for babies of 1 year to 15 months

6 a m	Milk and sugar	Tinned, goat, or dried, 1 cupful
10 a m	Ogi or ogi baba*	Cupful with sugar and milk
2 p m	Mashed yam or rice 4 to 6 teaspoonfuls or stale bread in 1 to 1½ cupfuls of stew or bone or vegetable soup Fresh meat juice, 1 teaspoonful if obtainable	
4 p m	Fruit juice, 1 cupful	
6 p m	Cupful ogi, or pawa†, with sugar and milk if obtainable	
10 p m	Milk and sugar	Tinned, goat, or dried, 1 cupful

Extras

Minced liver
Palm oil 2 teaspoonfuls daily
Cold boiled water between meals
1 egg lightly boiled or mixed with pawa when obtainable
Fresh fish steamed

Diet sheets for different age groups should be printed in the vernacular and read out to the mother who should then repeat it A copy should be given to her or to the father if either is literate Slight local modifications may be necessary

For school children, provision of midday school meals free or very cheaply is an obvious answer This may not be economically feasible, in which case the following measures may be adopted Health visitors, or school-teachers themselves, should be requested to visit the homes of malnourished children (who are easily recognized in a class as they are usually the most apathetic apart from having marked physical signs such as angular stomatitis) and advise the parents With the help of the Medical or Health Department, mass worming should take place in schools periodically In the absence of school meals stock vitamin tablets should be given to school authorities for daily or weekly distribution to children with signs of nutritional deficiency Although a good all round diet is the ideal, even when this is unattainable, avitaminosis as such can be attacked Some improvement will definitely be obtained It is known that minimal lack of specific vitamins in man causes recognizable and treatable mental and physical symptoms and signs The frequency of ulcers and their delay in healing may reflect the lowered resistance to infection and poor healing power associated with malnutrition, including deficiency of ascorbic acid Partial deficiency of the vitamin B-group may bring about easy fatigue, diminished appetite and subnormal gains in weight

If school meals are provided they should include red palm oil as an important source of vitamin A soups can be thickened with

* ogi - gruel made from maize flour
ogi baba - gruel made from sorghum flour

† pawa - porridge made from sorghum 'flakes'

brewers yeast or groundnut as good sources of the vitamin B-complex and consumption of citrus fruits (oranges, lemons) should be encouraged as good sources of ascorbic acid

The groundnut contains a good quantity of protein, and the important components of the vitamin B-group (thiamine, nicotinamide and riboflavin) In the absence of meat, it could help to make good the deficiency of these constituents It is only occasionally used in the African dietary, e g for thickening a stew thus making groundnut soup, or as a snack. Kenneth Prior, a missionary agriculturalist in Nigeria, has advocated the use of groundnut flour for a wide variety of purposes The storage properties and palatability of this product are worth investigating A small trial was made among a few Lagos families, with uncertain results

At the Veterinary Centre, Vom, experiments are being carried out in the production of skimmed milk If they are successful this will be useful, both economically and nutritionally, for general purposes and for the treatment of kwashiorkor

I wish to thank the Acting Director of Medical Services, Dr H C Weir, and the Acting Senior Health Officer, Dr D Ungar, both of Medical Headquarters, Western Region, who kindly arranged my tour Dr J L McLetchie, Adviser to Rural Health Services, Nigerian Medical Services, who granted me access to his considerable official records, all the wonderfully helpful personnel of the medical stations I visited, and Dr M E Johnston for invaluable assistance in the final stages of this work

REFERENCES

1 Adams, J (1952) *Personal communication*

2 Brock, J F & Autret, M (1952) *WHO Monograph Series No 8*

3 Bruce-Chwatt, L J (1952) *West Afr med J* I, 102

4 Hume, E M & Krebs, H A (1949) *Spec Rep Ser med Res Coun Lond* No 264

5 Jelliffe, D B (1952) *Brit med J* ii, 1131

6 Jelliffe, D B (1952) *Pediatrics Springfield*, 9, 544

7 McLetchie, J L (1952) *Personal communication*

8 Nicol, B M (1952) *Brit J Nutr* 6, 34

9 Silvera, W D & Jelliffe, D B (1952) *J trop Med (Hyg)* 55, 73

10 Walker, A H C (1952) *Personal communication*

11 Woodruff, A W (1951) *Brit med J* ii, 1415

DIAGNOSIS OF ACUTE KWASHIORKOR IN CHILDREN AT MULAGO

by

R F A Dean

The diagnosis of kwashiorkor has rested up to the present time on clinical observation, rather poorly supported by a few biochemical data Clinical observation does not usually lend itself to exact measurement, there is a wide variation in assessment, and the existence of what may be local variations of the signs has added to the confusion The need for more objective methods of diagnosis to be used in conjunction with the clinical findings is quite obvious and most of what I have to say deals with the possibility of finding and using such methods

In Kampala, kwashiorkor is a disease which can be regarded as a separate entity, with some distinctive clinical and biochemical features Every aspect of kwashiorkor cannot be discussed here but there are a few facts which are reasonably well proved and can be accepted The first is that kwashiorkor is a disease which occurs in communities where the staple diet is poor in protein, and especially in animal protein The second is that children in the acute stages of kwashiorkor usually have fatty infiltration of the liver, and various changes in the pancreas The third is that kwashiorkor can occur without any signs of accompanying disease, such as hookworm anaemia malaria or syphilis, or of any recognizable vitamin deficiency

The great majority of the children seen at Mulago are between the ages of one and two-and-a-half years, and are small for their ages There may have been some retardation of skeletal development, as shown by the height and by the X-ray appearances of the hand, and no child admitted for kwashiorkor has reached even the modest standard of weight compiled from more or less normal children attending welfare clinics in the vicinity of Kampala The weight is low despite the oedema, which is an almost constant feature and may represent from 10 to 30 per cent of the weight on admission This shows in the weight loss in the first few days of successful treatment

The children nearly always have alterations of the hair and skin The hair is usually fine and straight, and brown The skin shows a number of changes which Trowell *et al* [5,6] have described very fully One which must be considered characteristic of the disease as we see it begins with dark, purplish spots in the most superficial layers of the skin, fluids collect under the spots, the skin loosens and gets rubbed away and as the same process has been going on simultaneously in a number of adjacent places, large areas of skin are left denuded and weeping The groins, and parts subjected to continuous pressure, are most commonly affected Other extraordinary lesions are deep fissures which appear at sites of extreme

skin reflexion such as the junction of the ear and scalp, and deep, punched-out ulcers which occur sometimes on the dorsum of the foot Both these lesions show very little inflammatory reaction and seem to be relatively painless

Usually, the children have a moderate degree of anaemia, with haemoglobin averaging about 8 5g per 100ml and a red blood cell count of about 2 85m per cu mm so that the colour index is a little over unit They have no enlargement of the liver, the edge is usually palpable just below the costal margin but this does not represent a true enlargement of the li er so much as failure of the rest of the body to grow Davies[1] has collected the post-mortem weights of the li ers of children dying at Mulago, and the proportion of the weights to the total body weights is much the same whether the livers are fatty or not The children pass a small amount of protein in the urine, without any blood cells or casts

Elsewhere the clinical features may be somewhat differen The age at which children are most profoundly affected may be three to five years, the hair may be red, grey, or off-white, rather than brown, the typical dermatosis may be an appearance of the skin of the lower parts of the legs that can be described as brown 'crazy pa ing', the liver may be hard and so large as to reach the umbilicus These variations need not alter the diagnosis and they do not help much in defining the essential pathology of the disease

We have begun an attack on the biochemical pathology at Mulago and the findings in the serum are summarized in the table (taken from Dean and Schwartz[2]) On the whole they confirm what has been found elsewhere Three series of values are given for each of the serum constituents Those in the first series were found on admission and may be said to be consistent with a period of protein depletion The other values were found after 7 and 28 days treatment with a high protein diet Changes occurred for the greater part near the beginning of treatment The values at 28 days were near the accepted normal values for British and American children of the same age, except the albumin globulin ratios, which were low, and the blood urea values, which were high The latter is especially puzzling but we do not at the moment consider that the lability which they indicate is necessarily related to kwashiorkor, although that is a possibility The 28-day values are better regarded as 'standard' values obtained in relation to a known period in which the child has been eating a known diet, rather than as 'normal' for African children

Kwashiorkor results of the analysis of the serum of Mulago children on admission and after 7 and 28 days of treatment with a high protein diet

		On admission	After 7 days	After 28 days	Normal values
Total protein (g/100 ml)		3 98	6 00	7 00	6 5 - 7 5
Albumin "		1 51	2 52	3 60	4 4 - 5 5
Globulin "		2 44	3 40	3 60	3 4
A G ratio		0 67	0 81	1 00	2 0
Urea	(mg/100 ml)	16 2	43 0	50 0	20 - 25
Total cholesterol	"	87	160	140	150 - 180
Free "	"	66	77	56	60 - 75
Ester "	"	21	83	84	90 - 95
Free total " "		0 76	0 48	0 40	0 2 - 0 3
Amylase	(Units)	25	90	100	60 - 200
Esterase	"	16 8	45	43	Unknown
Cholinesterase	"	0 24	0 36	0 60	0 6 - 0 8
Alkaline phosphatase	"	11 8	9 5	18 0	15 - 20

Details of methods and units are described by Dean and Schwartz[2]

The figures shown are averages of 10 to 30 estimations

The normal values are those for children in the U S A aged one to three years

An isolated estimation, or a set of estimations in a single blood sample, even if the child is in the acute and untreated condition, helps much less in diagnosis than the repetition of the estimations during treatment The initial values shown in the table constitute an aid to the diagnosis of kwashiorkor and their subsequent alteration when a correct high protein diet is given also helps in the diagnosis Within a few days of the beginning of successful treatment the child rapidly loses his oedema, and there is a close connection between the loss of the oedema and the rise in the serum albumin, a point that helps to characterize the oedema Water presumably leaves the blood stream, and this must affect the concentration of substances in the serum, but the changes found after a week's treatment represent more than can be accounted for by the withdrawal of water The changes do not all occur at exactly the same rate, and there must be active regeneration of many substances, even in this short period The curative diets may provide small amounts of some substances for example cholesterol, that appear in the blood stream, but serum proteins, and all the enzymes, are not obtained in this way They must be synthesized in the body

A large number of synthetic processes seem to begin, suddenly, to function at a high level of efficiency The processes must involve many organs A rise in serum albumin reflects increased synthetic activity in the liver and cholesterol may be made at many different sites, including the brain Another organ that must be involved is the pancreas, which was probably the site of manufacture

of most of the serum amylase and esterase estimated Every organ, and every part of the body, probably takes part in this astonishing revival of vital activity

Confirmatory evidence for the pancreas is available from the study of pancreatic secretion into the duodenum by Thompson[3,4] at Mulago She has found very low values for the activity of trypsin, lipase and amylase in the acute stage of the disease and much higher values after a period of high protein feeding Some interesting preliminary results have been obtained by following up this work with balance studies* One child, in the first balance period of four days when he was acutely ill, absorbed 73 per cent of the nitrogen in his diet, and 86 per cent of the fat, after 25 days treatment with a soya banana diet, he absorbed 79 per cent of the nitrogen and 96 per cent of the fat The ratio of urinary N faecal N improved from the very low figure of 0 9, corresponding to the urinary excretion of nearly a third of the nitrogen in the diet, to 3 1

Kwashiorkor as seen at Mulago is considered to be a disease in whose aetiology protein deficiency is dominant We believe that all the evidence from serum proteins and enzymes, duodenal enzymes, and balance studies, points in the same direction The changes that seem to be characteristic of the cure of the disease occurred when large amounts of cow's milk and soya were added to the diet, and although we know that these foods supplied many substances besides protein, the protein is believed to play a very important part The nature and speed of the changes appear themselves to constitute diagnostic features which are probably specific

It is not difficult to invent other tests that might be used in diagnosis For instance, a test might be based on the fact that small amounts of milk fat, or lactose, cause immediate diarrhoea If collection of urine and faeces were a little easier, the ratio of urinary to faecal nitrogen would tell a great deal about the recovery of enzymatic activity A test of a different kind might depend on the water balance in kwashiorkor, at the moment we know little except that the balance is easily upset, but the reaction to the intravenous injection of osmotically active material, such as serum or dextran, might be very informative, and so might the investigation of the rate of excretion of a test dose of water given by mouth

The ideal method of objective diagnosis would be the estimation of a substance which occurred naturally in the body, whose concentration was known to depend on the integrity of many body processes At the present time we cannot name with certainty any such substance - although a good case might be made out for serum albumin - and we have to rely on a battery of estimations Tentatively, it is suggested that estimation of the serum albumin and total protein, the

* I would like to acknowledge the help of Mrs J N P Davies in these studies

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Globulin "	2 44	3 40	3 60	3 4
A G ratio	0 67	0 61	1 00	2 0
Urea (mg/100 ml)	16 2	43 0	50 0	20 - 25
Total cholesterol "	87	160	140	150 - 180
Free " "	66	77	56	60 - 75
Ester " "	21	83	84	90 - 95
Free total "	0 76	0 48	0 40	0 2 - 0 3
Amylase (Units)	25	90	100	60 - 200
Esterase "	16 8	45	43	Unknown
Cholinesterase "	0 24	0 36	0 60	0 6 - 0 8
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A large number of synthetic processes seem to begin, suddenly, to function at a high level of efficiency The processes must involve many organs A rise in serum albumin reflects increased synthetic activity in the liver and cholesterol may be made at many different sites, including the brain Another organ that must be involved is the pancreas, which was probably the site of manufacture

There are, of course, many differences, but the one which seems likely to be of the greatest importance is that milk contains cyanocobalamin (vitamin B_{12}), and maize does not. No entirely vegetarian diet supplies this vitamin, but evidence is accumulating that it is closely connected with the metabolism of methionine The connection is with methyl groups rather than with thiol groups The vitamin is involved in the production or activation of methionine-forming systems, which are probably less fully developed in infancy than in adult life In its absence there may be delay in the transfer of methyl groups from betaine When it is present the need for methionine may be reduced, and the amino-acid may lose some of its essential character and be replaceable by other substances It is one of the so-called 'lipotropic' substances, which help to remove fat from the liver, and in this action it is more effective in conjunction with methionine than either is alone What part does cyanocobalamin play in the aetiology of kwashiorkor? It does not seem entirely unreasonable to suggest that it may be intimately concerned with any enzyme systems which are sustained by methionine

Perhaps some attempt should be made to summarize these conflicting speculations They lead, I believe, towards the view that in kwashiorkor there may be a failure of protein synthesis, associated with the lack of enzyme activators or re-activators, and of an accelerator of transmethylation According to the quality of the diet, these may appear in different degrees, but the complete triad may be diagnostic We have, I believe, been observing, in different parts of the world, different manifestations of a disease that may everywhere have the same cause Success in the diagnosis of kwashiorkor, as of any other disease, ultimately depends on the ability to reduce the problem to its essentials The common origin of all kinds of kwashiorkor seems to be protein deficiency, qualitative or quantitative Variations may be brought about by many different factors such as different supporters of the staple in the diets, abundance or lack of calories, associated vitamin deficiencies, and chronic infections

REFERENCES

1 Davies, J N P *Personal communication*

2 Dean, R F A & Schwartz, R *(1953) Brit J Nutr 7, 131*

3 Thompson, M D *This Report p 208*

4 Thompson, M D & Trowell, H C *(1952) Lancet,* i, *1031*

5 Trowell, H C *(1949) Trans R Soc trop Med Hyg* 42, *417*

6 Trowell, H C , Davies, J N P & Dean, R F A *(1952) Brit med J* ii, *798*

7 Waterlow, J C *(1950) Lancet* i, *908*

ratio of free to total cholesterol, and of an enzyme such as esterase, will cover much of the chemical pathology

It is of the utmost importance to bear in mind the possibility of finding a common initial defect underlying all the pathological changes that occur in kwashiorkor Although our knowledge of the enzyme chemistry is still small, the most likely common defect is a more or less generalized failure of enzyme production If our knowledge were more thorough, we might be able to distinguish between enzymes which were much affected and those which were less affected At the moment there is only one shred of evidence of this kind and I am not sure if it is admissible Waterlow[7] investigated some children in Fajara who may have had a disease different from that which is seen in Kampala - and found, as we did, reductions of cholinesterase activity When the children recovered, the activity rose He also estimated - and here I think he showed great perspicacity - liver cytochrome oxidase and lactic dehydrogenase, and discovered that they were apparently unaltered by the disease The number of estimations was very small, and I think the work should be repeated, but this negative observation may turn out to be of importance

Cytochrome oxidase and lactic dehydrogenase are enzymes which differ from cholinesterase in one notable respect they do not require thiol (-SH) groups for their activation Cholinesterase, pancreatic esterase and lipase, and probably amylase, all need thiol groups and their activity is reduced in acute kwashiorkor and increases during recovery Can we then, look upon kwashiorkor as a deficiency disease produced largely by a lack of thiol groups? Failure of enzyme action could be explained in many other ways For instance, if the thiol groups of many enzymes are oxidized to -S-S groups, catalytic activity disappears and glutathione is needed to restore it It may be that in kwashiorkor the thiol groups are in the oxidized state, and that the true deficiency is of glutathione It can be argued, however, that if thiol groups are to be provided from sources outside the body, they must be derived from the sulphur-containing amino-acids cystine and methionine, and that cystine is needed for the formation of glutathione A vegetarian diet which is low in total protein is likely to be deficient in methionine, we suspect that the cooked banana (plantain)* is short of methionine, and Close † of IRSAC at Katana, has found the same to be true of cassava Is there any connection between these findings and the occurrence of kwashiorkor? Does kwashiorkor ever occur if the diet contains a large supply of methionine? Maize protein is a rich source of both cystine and methionine and yet kwashiorkor has been reported in maize-eating peoples Cow's milk protein contains about the same amounts of cystine and methionine as maize protein, and yet milk is universally recognized to be protective against kwashiorkor What is the difference between the two foods, other than their amino-acid composition, of importance in the aetiology of the disease?

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* See footnote p 310

† Refer to p 249

The children have been divided into two main groups, Ganda (local) and non-Ganda (immigrants), and again into age groups. In each age group the proportion of Ganda to non-Ganda is remarkably similar. Age groups have been made containing neonates under three months and then I have grouped the children in six-monthly periods about the ages of six months, one year, 18 months and so on. But there were so few cases in the age group 3½ to 4 years and thereafter so few round the midyearly figure that the 3½ to 4 group has been combined with the 4 to 5 group and thereafter the groups are in yearly periods 5 to 6, 6 to 7 and so on. I consider that up to the age of one year the ages are accurately stated, the accuracy is fair up to four years and thereafter the ages can only be considered as roughly accurate. The bulk of the admissions are under the age of four years. The distinction between tribes is accurate save possibly for the fact that some non-Ganda may have passed themselves off as Ganda as a mark of their assimilation into Buganda.

Almost every child admitted had a blood slide examined for malaria parasites, a natural precaution in a hospital in a hyperendemic malaria area. But to record all cases with positive blood slides as cases of malaria would be most misleading. From the records it is clear that my colleagues recognize, as would be expected, three separate conditions in which the blood slide is positive

(a) malaria, uncomplicated by any other condition
(b) malaria, complicated by another disease, either the malaria or the other disease necessitating admission
(c) some major disease where malaria is a minor complication and would not of itself necessitate admission. In some examples there may be a marked parasitaemia, in others several slides may have yielded only a single parasite.

The groups appear to me to be reasonably clear and distinct There is a striking and a highly significant difference between Ganda and non-Ganda in the incidence of malaria in the neonatal period, and to a less extent in the period about six months. While only 7 per cent of the Ganda admissions in the neonatal period and 28 per cent in the six months group were for malaria, 65 per cent of the non-Ganda admissions in the neonatal period were for malaria and 44 per cent in the six months group. I cannot see any peculiar local factor to account for this and have no explanation. It is possible that the maternal immunity handed on from the non-Ganda mothers is not effective against the local strains of falciparum malaria, however effective it might be in their home areas How far this difference between Ganda and non-Ganda in these early months of life is seen in children not admitted to hospital I cannot say In non-Ganda, the peak percentage of malaria was in the neonatal period, although the greatest number of cases were about one year old In Ganda, both the peak percentage and the greatest number of cases occurred in the 'one-year-old group'. In both, the malaria incidence fell more or less steadily up to the age of six to eight years.

ANALYSIS OF MORBIDITY AND MORTALITY IN CHILDREN AT MULAGO HOSPITAL 1950-1

by

J N P Davies

Sick children in Kampala present much the same problems as elsewhere in the tropics. Paediatricians and hospital beds are few and admission has to be restricted to those severely ill, and many who in more favoured lands would be admitted without question have perforce to be treated as out-patients. The conclusions reached by a survey of children admitted to Mulago Hospital, which deals with a highly selected group of patients, must be treated with due reserve

An analysis is presented of the causes of morbidity of some 2,600 children admitted to Mulago Hospital 1950-1 * The interpretations of these records are entirely my responsibility but I shall check these against the opinions of Dr. Trowell who was responsible for the care of many of the children. All available records of children have been scrutinized and I am satisfied that there are no serious omissions. Cases where the age, sex or tribe was not recorded, about 100 in all, have been rejected and again I am satisfied that this does not materially alter my findings as they did not fall in any particular groups of diseases.

Kampala is the capital of the Kingdom of Buganda and hence the majority of our patients are Ganda, though a considerable number are non-Ganda, being immigrants from many different tribes who have come to live in rural or peri-urban locations around Kampala Few of these have lived in the environs of Kampala for any great length of time, and the majority of non-Ganda mothers must be looked on as relatively recent arrivals. Few live within the Municipal boundaries where malaria is controlled, and the great majority live in the surrounding areas where malaria is hyperendemic with transmission throughout the year, although accentuated in the wet season. Though all types of malaria occur, most infections are due to falciparum malaria and so the term malaria here used covers all species

The investigations of Welbourn and Brock and Autret[1] have shown that for the first months of life the children, as regards weight, are roughly equivalent to European children and that at about nine months the weight curve begins to lag Breast feeding is prolonged and the banana is the staple diet for adults and children

* I am grateful to my clinical colleagues for permission to utilize their case records and to my fellow pathologists for permission to use their autopsy protocols

The children have been divided into two main groups, Ganda (local) and non-Ganda (immigrants), and again into age groups. In each age group the proportion of Ganda to non-Ganda is remarkably similar. Age groups have been made containing neonates under three months and then I have grouped the children in six-monthly periods about the ages of six months, one year, 18 months and so on. But there were so few cases in the age group 3½ to 4 years and thereafter so few round the midyearly figure that the 3½ to 4 group has been combined with the 4 to 5 group and thereafter the groups are in yearly periods 5 to 6, 6 to 7 and so on. I consider that up to the age of one year the ages are accurately stated, the accuracy is fair up to four years and thereafter the ages can only be considered as roughly accurate. The bulk of the admissions are under the age of four years. The distinction between tribes is accurate save possibly for the fact that some non-Ganda may have passed themselves off as Ganda as a mark of their assimilation into Buganda.

Almost every child admitted had a blood slide examined for malaria parasites, a natural precaution in a hospital in a hyperendemic malaria area. But to record all cases with positive blood slides as cases of malaria would be most misleading. From the records it is clear that my colleagues recognize, as would be expected, three separate conditions in which the blood slide is positive

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The groups appear to me to be reasonably clear and distinct. There is a striking and a highly significant difference between Ganda and non-Ganda in the incidence of malaria in the neonatal period, and to a less extent in the period about six months. While only 7 per cent of the Ganda admissions in the neonatal period and 28 per cent in the six months group were for malaria, 65 per cent of the non-Ganda admissions in the neonatal period were for malaria and 44 per cent in the six months group. I cannot see any peculiar local factor to account for this and have no explanation. It is possible that the maternal immunity handed on from the non-Ganda mothers is not effective against the local strains of falciparum malaria, however effective it might be in their home areas. How far this difference between Ganda and non-Ganda in these early months of life is seen in children not admitted to hospital I cannot say. In non-Ganda, the peak percentage of malaria was in the neonatal period, although the greatest number of cases were about one year old In Ganda, both the peak percentage and the greatest number of cases occurred in the 'one-year-old group' In both, the malaria incidence fell more or less steadily up to the age of six to eight years.

If we compare uncomplicated malaria (group a) with major diseases complicated by malaria (group c), we find that up to the age of 18 months there were more cases of uncomplicated malaria, but that after this age there were in both Ganda and non-Ganda slightly more cases of major diseases complicated by malaria

Two quite separate and distinct groups of types of malnutrition were examined namely (a) underfeeding starvation or marasmus, and (b) kwashiorkor No other types of malnutrition were seen A distinction is clearly shown for, in both Ganda and non-Ganda, marasmus is predominantly found in the early months with very few cases occurring thereafter, while kwashiorkor is not seen in the neonatal period, is uncommon in the six months group, and rises to an ill-sustained peak in Ganda children at the age of 18 months followed by a fairly rapid fall after the age of 3 years few cases were seen Among non-Ganda the disease was uncommon before 1 year and the incidence rose more or less parallel to the rise in Ganda to reach a plateau at 18 months The incidence did not then fall away as in Ganda children, but continued on much the same level to about 3½ years of age (the figures here are fallacious) with a fair number of cases occurring up to the 6 to 7 age group

There is thus no reflection in the non-Ganda children with kwashiorkor of the high incidence of severe malaria in the early months of life If malaria played any important part in the aetiology of kwashiorkor, the severity of malaria in non-Ganda in the early months of life might be expected to advance the date of the onset of kwashiorkor The figures fail to show any evidence of this and support the view that malaria plays no major part in the aetiology of kwashiorkor Indeed, it would not be expected to, as kwashiorkor occurs in parts of the world where neither malaria nor other tropical parasites exist In Kampala we can also dismiss ascaris, tapeworms, schistosomes *Entamoeba histolytica* and I think, hookworms also, from any role in the aetiology Ancylostomic infestation was insignificant in the first year of life The incidence in Ganda children was fairly uniform in the ages 1 to 10 years In the non-Ganda there is, from the ages of 2½ years onward, a significant excess of kwashiorkor, of ascaris infestation of ancylostome infestation and also of measles Though helminthic infestations may play a part in prolonging or aggravating a kwashiorkor phase, I cannot find evidence to suggest they play any part in the aetiology

The only other conditions that could possibly be incriminated at Mulago Hospital were the respiratory infections Under the title of upper respiratory infection (U R I) are included all infections of the mouth tonsils and hypopharynx as well as of the upper air passages In children, as in adults in Uganda, U R.I and other respiratory infections are very common[4], and pneumonia is very frequently seen[2], but the incidence is more or less the same in all groups and appears to have no particular relationship to the incidence of kwashiorkor

Thus Kwashiorkor with a maximal age incidence in the years 1-to 3 seems to stand quite alone, and though malaria and other conditions may complicate, prolong or aggravate it, the aetiology would appear to be quite distinct The operative factors that precipitate Kwashiorkor must act in the main in the period after the ninth month, at which time we know the mother's milk is failing to meet the needs of the child and supplementation is becoming urgently necessary I do not propose to explore the problem of the aetiology of Kwashiorkor more deeply, as this will be done by others, but to turn to some other points which arise in this analysis of morbidity Firstly, I would like to point out the infrequency of frank cirrhosis of the liver in these children Although most children show an increase in the amount of fibrous tissue in the liver only one certain and one suspected case of cirrhosis were seen, both in older children, plus one case of infective hepatitis Cirrhosis of the liver at Mulago is a disease of the twenties and thirties, though a number of cases are seen in the late teens No case of infantile biliary cirrhosis similar to those reported from India has been seen, nor has the picture of serous hepatosis and collagenosis of the liver as seen in the West Indies been encountered

Another curious point was the relative infrequency of acute gastro-enteritis Diarrhoea and vomiting figured prominently on the admission notes but in most cases they were associated with malaria and subsided rapidly on resolute treatment of the malaria I cannot explain why acute gastro-enteritis was so infrequently encountered on the case records, or seen *post mortem* Welbourn[5] has also remarked on the unexpected infrequency of acute gastro-enteritis in clinic children in and around Kampala

Tables 1 and 2 deal in detail with the parasitic and infective complications of Kwashiorkor in children, excluding respiratory complications which are so frequent as to be almost a part of the disease The figures are shown for Ganda and non-Ganda separately It is probable that more cases were complicated by parasites and non-respiratory infections than are shown in the tables, which include some short stay cases others dying soon after admission and others not fully investigated Nevertheless, during this period active investigation into Kwashiorkor was going on under Dr Margaret Thompson and under Dr Dean[3] who informs me that of 75 carefully investigated cases 35 were without parasitic or non-respiratory infections These tables therefore must be approximately correct in showing the relationship of Kwashiorkor to parasitism in Kampala There is no evidence here to suggest that parasites are particularly responsible for prolonging the Kwashiorkor phase in non-Ganda

The autopsy findings are not greatly different from those published previously from Mulago Hospital[2] Autopsies were performed only on 106 out of 246, a percentage far below that achieved in the case of adults dying at Mulago Table 3 shows the presumed cause of death in the 140 cases which were not examined *post mortem* Malaria, pneumonia, Kwashiorkor and tuberculosis were the major causes of death Most of the deaths from these conditions occurred in the earlier years of life until about the age of two years when they began to fall off Malaria was a steady killer up to the age of three years but the greatest number of deaths was at about one year Kwashiorkor killed at the ages of 1 - 3 years With the exception of malaria it is to be noted that diseases regarded as specifically tropical killed only three children out of 140,

…e 1 *Incidence of kwashiorkor, with and without complications, among 142 Ganda children*

…omplications	Approximate age							
	3 - 9 months	9 - 15 months	15 - 21 months	21 months to 2¼ years	2¼ - 2¾ years	2¾ - 3¼ years	3¼ - 8 years	Total
	2	9	19	9	4	3	2	48
…omiasis			5	7	4	3	2	21
…nt tertian malaria	1	11	25	14	2	2	3	58
…cylostomiasis + m t malaria	1		2	4		1	1	9
…scariasis			1					1
Tuberculosis			1	1				2
Pyomyositis			2					2
Schistosomiasis*							1	1

*Schistosoma mansoni

Table 2 *Incidence of kwashiorkor, with and without complications among 88 non-Ganda children*

…ions	Approximate age							
	3 - 9 months	9 - 15 months	15 - 21 months	21 months to 2¼ years	2¼ - 2¾ years	2¾ - 3¼ years	3¼ - 8 years	Total
…mplica…	3	3	7	9	2	5	3	32
…ylostomiasis …ria		1	2	3		1		7
…lignant tertian mala… malaria	2	4	5	6	5	1	2	25
…ylostomiasis + m t … is			2	2	1	4	4	13
Ascariasis			1	1		1	2	5
Ascariasis + ancylostomia…is					1			1
Ascariasis + ancylostomias… + m t malaria				1				1
Ancylostomiasis + taeniasis				1				1
Ancylostomiasis + amoebiasis						1		1
Ascariasis + m t malaria						1		1
Bacillary dysentery		1						1

…ophary… In adult… …ery co… …e is … …ticul… …ons …) are

Table 3 *Analysis of causes of death of 140 children on whom autopsies were not performed*

Causes of death	Approximate age								
	Under 3 months	3 - 9 months	9 - 15 months	15 - 21 months	21 months to 2¼ years	2¼ - 2¾ years	2¾ - 3¼ years	3¼ - 8 years	Total
Pneumonia	6	6	8	5	2	1		3	31
Malaria	1	3	8	2	2	2	3	3	24
Kwashiorkor			3	2	4			2	11
Meningitis	2	5	1						8
Skin sepsis	5							2	7
Whooping cough	2	1	1		1			1	6
Dysentery	1	2	2						5
Anaemia - hookworm				1	1			3	5
Tuberculosis			1		1			2	1
Intussusception		1			1			1	3
Trauma		1		1				1	3
Miscellaneous*	1	8	4	3	1	1		4	22
Unknown	1	3	2	1	1	1		2	11

* One or two cases of each of measles, marasmus, congenital syphilis, cancer, poliomyelitis, tetanus, thrush, cardiac failure, laryngeal obstruction, otitis media, encephalitis, foreign body in bronchus, acute internal obstruction, amoebiasis, polyarthritis, empyema, hare lip, and retropharyngeal abscess

(11926)

Table 4 *Analysis of causes of death of 106 children on whom autopsies were performed (Ganda and non-Ganda children are shown separately thus 2 1, 0 2, etc)*

Causes of death	Approximate age								Total
	Under 3 months	3 - 9 months	9 - 15 months	15 - 21 months	21 months to 2¼ years	2¼ - 2¾ years	2¾ - 3¼ years	3¼ - 10 years	
Kwashiorkor		2 1	0 2	3 4	0 4	1 0		0 4	21
Bronchopneumonia	0 2	1 0	2 0	2 0	3 2		1 2		15
Malaria	2 1	1 0	2 0	1 3	0 1		0 1	0 1	13
Tuberculosis	1 1	0 2	0 1	1 0		1 0	0 1	0 2	10
Lobar pneumonia	0 1	2 0	0 3	0 1					7
Meningitis	3 0	1 0	0 1						5
Cancer							0 1	2 1	4
Acute gastro-enteritis	1 1	1 0							3
Inanition	1 2								3
Miscellaneous*	3 2			3 1	0 1		2 1	5 4	22
Unknown infection				1 0				2 0	3

* One or two cases of each of typhoid, cardiac failure pancreatitis, nephritis, sickle cell anaemia, tetanus, Hodgkin's disease giant cell pneumonia diphtheria, trauma hookworm anaemia, peritonitis, amoebiasis, cerebral haemorrhage choroiditis, and abscess

Histological examinations were made in 83 cases

hookworms - two, and amoebiasis - one, exactly the same number of deaths and the same parasites as were found in the 102 children on whom autopsies were performed (table 4) It can also be seen from this table that malaria, pneumonia, kwashiorkor and tuberculosis were the major killing diseases, and apart from malaria the so-called tropical diseases hardly came into the picture There is little difference of significance between tables 3 and 4

Summary

A survey has been made of 2,649 children who were admitted to Mulago Hospital, Kampala, in the years 1950-1, and of the causes of death in 246 children who died in hospital in the same period

The major causes of morbidity and mortality were malaria, respiratory infections and kwashiorkor Apart from malaria, diseases caused by tropical parasites were not frequently seen

During the early months of life there was a significantly greater amount of malaria among immigrants living near Kampala than among the indigenous people, but this was not reflected by an earlier onset of kwashiorkor

Kwashiorkor is a disease of the weaning period and was the major cause of morbidity and mortality in the one to three years age period Infection and infestation appeared to play no part in the aetiology of kwashiorkor

Certain features of paediatric interest revealed by the tables are briefly discussed

REFERENCES

1 Brock, J F & Autret, M *(1952) Bull World Hlth Org* 5, 1

2 Davies, J N P *(1948) E Afr med J* , 25 *228*

3 Dean, R F A *(1952) Personal communication*

4 Ladkin, R G *(1952) E Afr med J* , 29, *72*

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Kwashiorkor			2	1	0	2	3	4	0	4	1	0			0	4	21
Bronchopneumonia	0	2	1	0	2	0	2	0	3	2			1	2			15
Malaria	2	1	1	0	2	0	1	3	0	1			0	1	0	1	13
Tuberculosis	1	1	0	2	0	1	1	0			1	0	0	1	0	2	10
Lobar pneumonia	0	1	2	0	0	3	0	1									7
Meningitis	3	0	1	0	0	1											5
Cancer													0	1	2	1	4
Acute gastro-enteritis	1	1	1	0													3
Inanition	1	2															3
Miscellaneous*	3	2					3	1	0	1			2	1	5	4	22
Unknown infection							1	0							2	0	3

* One or two cases of each of typhoid cardiac failure pancreatitis, nephritis sickle cell anaemia, tetanus, Hodgkin's disease, giant cell pneumonia diphtheria, trauma, hookworm anaemia, peritonitis, amoebiasis, cerebral haemorrhage choroiditis, and abscess

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OBSERVATIONS ON THE EFFECT OF MALARIA ON GAMBIAN INFANTS AND YOUNG CHILDREN

by

I A McGregor

The high incidence of diseases such as malaria, filariasis and ancylostomiasis in the people of the Gambia has repeatedly rendered almost impossible accurate assessment of the part played by dietary insufficiency in the production of ill health In no age group is this more clearly marked than in infancy and early childhood, when heavy malarial infection is almost universal

In June 1951 at a Government infant welfare centre near Fajara, an experiment was started which would, it was hoped, determine precisely the effects of heavy malarial infection upon infant health

Over a period of six months every other child born in the villages around the welfare centre was placed on a weekly suppressive dose of chloroquin, while the alternate infants were kept as unprotected controls This latter group was not denied anti-malarial treatment when it was required The sister in charge of the clinic was advised that she should not regard the non-chloroquin infants as being different in any way from infants normally attending the centre, and that should any one of them in her opinion, require anti-malarial treatment, she was at complete liberty to administer any standard therapeutic course normally prescribed at Gambian dispensaries

The diet of the infants was not interfered with but no supplements, e g skimmed milk powder, were supplied to any child of the experimental groups The diet therefore, was breast milk later augmented by paps made from the cereals commonly used by Gambian people

Blood films were examined for malaria parasites, weekly in the case of protected children and monthly in the control groups In addition where possible, each child, protected and unprotected was examined monthly, the points noted being weight, size of liver, size of spleen, colour of hair and haemoglobin value

In March 1952, a similar experiment using daraprim (2 4 - diamino-5-p-chlorophenyl-6-ethylpyrimidine) in weekly dosage was started at another infant welfare centre to permit confirmation of observations made during the chloroquin trial

The chloroquin experimental group at the start comprised 26 protected infants and 26 unprotected controls Unfortunately, four of the control group have since left the area The daraprim group numbered 12 protected and 12 unprotected

Although this experiment has not yet been completed, certain differences between the protected and unprotected children merit a preliminary report of results The results of the observations are summarized in the table

Summary of observations on Gambian infants, protected and unprotected against malaria

		Protected			Unprotected		
		chloroquin series	daraprim series	combined	chloroquin series	daraprim series	combined
No in group November 1952		25	12	37	17	12	29
Mean birth weight	oz	102 4(2 90kg) (SD = 4 07)			102 8(2 91kg) (SD = 3 00)		
Mean weight gain in first year	oz	202 4(5 74kg) (SD = 6 40)			191 5(5 51kg) (SD = 6 80)		
Parasitaemia	percentage						86 2
Splenomegaly	percentage						79 3
Mortality rate	percentage	3 8			19 2		
Liver palpable below costal margin	percentage*			13 5			79 3
Mean haemoglobin	g %*	12 1 (SD = 1 00)	12 0 (SD = 0 46)		9 5 (SD = 1 22)	10 3 (SD = 0 62)	
Hair dyspigmentation	percentage	32			53		

SD = standard deviation
* differences between protected and unprotected statistically significant

The **parasitaemia** is strikingly different in the protected and unprotected groups The species of parasite found have been *Plasmodium falciparum*, *P malariae* and *P ovale*

Spleen rates were also markedly different

One child of the chloroquin protected series has died since the start of the trial Five children of the chloroquin unprotected series have died over the same period No deaths have occurred in either of the daraprim series The difference in **mortality rates** is not statistically significant

The mean birth **weights** of protected and unprotected infants in the chloroquin series are almost identical The difference in mean weight gain over one year in the two groups was 7 8 ounces in favour of the treated infants Statistically, the difference in body weight gain over one year in the two groups is not significant

Variations in **liver size** in children of both daraprim and chloroquin series, as judged by palpation, were

	Treated group	Untreated group
(a) Liver not palpable	27	2
(b) Liver palpable at, but not below, costal margin in nipple line	5	4
(c) Liver palpable below costal margin in nipple line	5	23

The mean **haemoglobin** of the unprotected infants was significantly lower than that of protected infants in both series

Dyspigmentation of hair was not significantly different in chloroquin protected and unprotected infants though more showed this change in the latter group

Examples of malnutrition in infants and children

by

H C Trowell and A J Hawe

Dr HAWE regretted that it was not possible to demonstrate a clinical case of kwashiorkor as he had hoped, as the disease was not common in the neighbouring villages One or two cases of what had first been presumed to be kwashiorkor had turned out to be nephritis

Dr TROWELL said that he had been unable to find in the Gambia and present to the meeting any typical case of severe kwashiorkor with oedema and the characteristics of dermatosis, very few cases having been reported* in this country In presenting two cases, one of moderate undernutrition certainly complicated by, if not partly caused by, malaria, and another of moderate kwashiorkor apparently without active malaria, he hoped to focus attention on these two aspects of malnutrition complicated as they are in the tropics by malaria and other infections

The first child, a female Mandingo born on 9 4 52 had attended weekly an infant welfare centre There had been occasional attacks of fever for which treatment had been given For the past three months the weight had been stationary at 10 lb (4 kg) The child had been breast fed from birth

When admitted to the MRC research ward on 15 11 52 the child was lively and often tugged at her mother's breast There was moderate pallor of the mucous membranes, the spleen was enlarged two fingerbreadths below the costal margin but the liver was not palpable The rectal temperature was only 99 2^{O}F but the thick blood smear showed approximately two malignant tertian malaria rings per field Chloroquin 6mg per kg was given at once and two days later the thick blood smear was negative

The weight, however, remained stationary, the child continued to show signs of hunger the hair was crisp and black in colour and there was no oedema A number of test feeds were given during three successive days, covering all hours of the day and night These revealed an intake of approximately 15 oz (0 42 litres) of breast milk of unknown but presumably almost normal composition The breast milk was therefore supplemented by whole cow's milk, one pint (0 57 litres) daily which was readily accepted The child's weight stationary from the date of admission to hospital, immediately started to rise and 1 to 2 oz (28 to 57 g) in weight were gained daily

Some difference of opinion was expressed concerning the presence of oedema Professor PLATT considered that some oedema was present,

* It is true that the diagnosis 'kwashiorkor' has not been used in my ward this does not however, mean that examples of this syndrome as defined by Trowell and others do not occur in the Gambia I have used the diagnosis 'malnutrition cause not known' for cases which would have been called kwashiorkor at Mulago - B S P

The parasitaemia is strikingly different in the protected and unprotected groups The species of parasite found have been *Plasmodium falciparum*, *P malariae* and *P ovale*

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Dyspigmentation of hair was not significantly different in chloroquin protected and unprotected infants though more showed this change in the latter group

When presented, the patient had soft brown hair, no oedema, no changes in the skin and mucosae, no enlargement of liver and spleen and no pallor The red blood cell count was 4,830,000 per cu mm and Hb 12 0 g (Dare) The stools were still bulky and loose, but contained much less undigested starch Appetite was good and since skimmed milk had been added to the diet the child had eaten all her rice pap

In Dr Trowell's experience in Uganda this second case would always show much reduction in the pancreatic enzymes and in the serum albumin, and biopsy would probably disclose a fatty liver There would also be many features found only in cases of severe kwashiorkor, and eventually the characteristic dermatosis and signs of vitamin deficiency might develop None of these features would be markedly present, if at all, in the first case of underfeeding and malaria The second case would not respond to an increase of food and was refusing food, but responded to the addition of protein to the diet

Professor MONCRIEFF queried whether a firm distinction could be made between undernutrition and kwashiorkor in the cases presented to the meeting Would Professor Raoult accept the second case as suffering from kwashiorkor?

Professor RAOULT submitted that the case demonstrated might be described more appropriately as a pre-kwashiorkor case which eventually might develop into kwashiorkor He regarded the oedema as only very slight, but the case had already been treated Cases at Dakar had been more serious, including marked reddening of the hair, and dermatosis

Dr TROWELL agreed, adding that the main criterion of kwashiorkor might be tested by the simple addition of small amounts of skimmed milk powder to the normal diet

Professor PLATT drew attention to the fact that the Mandingos did not give food other than breast milk until the infant was many months old the Jola mothers, however, gave pap early The second patient demonstrated had a Jola mother

Dr TROWELL warmly agreed that the age at which pap food was given was of fundamental importance

Dr UNDERWOOD GROUND and Dr SQUIRES both drew attention to the fact that African mothers in their respective areas failed to ask for medical advice unless their children had marked symptoms and were seriously ill, so that in hospital they would only see cases of severe kwashiorkor Dr Squires also asked whether anyone could tell him the natural history of kwashiorkor what for example, were the chances of an untreated case (a) making a spontaneous recovery, (b) progressing slowly downhill, with spontaneous remissions and (c) pursuing a swift inexorable downhill course

but Professor MONCRIEFF and Professor GYORGY were unable to confirm this Professor PLATT also stressed the presence of anaemia and his views were upheld by the red blood cell count, which was 2 230 000 per cu mm, and the haemoglobin reading, which was 7 0 g on *the Dare haemoglobinometer* Dr TROWELL agreed that malaria and anaemia complicated the case

Dr Trowell then showed a second patient who in his opinion, was suffering from kwashiorkor of moderate degree The child, a female Jola, was two years of age, but only weighed 12 lb (5 4 kg) The child had been breast fed until one month ago, rice pap had been given from some uncertain time during the first year of life, and only a soup containing some fish, had been given in small amounts two or three times daily since that age There had been no shortage of food in the home and few recognized periods of fever All these facts suggested that the child had been able to satisfy his calorie requirements, but had been on a diet containing only a small amount of protein

The mother considered that the child had ceased to grow from about the age of one year her height was only 29 inches (74 cm) in November 1952 At the age of one year she had developed brown soft hair and often passed loose stools During the second year of life this state of affairs remained and the child was often fretful Oedema of the legs started in October 1952 The child was admitted to Bathurst hospital on 3 11 52 There was no fever, and no report could be found on the blood an injection of three grains of quinine was given and weaning was advised The child continued to be given rice pap without cow's milk, and moderate oedema of the legs remained

When the child was admitted to the MRC research ward on 14 11 52, the hair was brown and soft, there was no pallor or dermatosis of the skin, and no cheilosis or changes in the tongue She was extremely apathetic and irritable and showed a small amount of oedema in both legs There was no subcutaneous fat The muscles were wasted The liver and spleen were not palpable and the thick blood smear was *negative There had been no fever and no antimalarial* treatment had been given There was no albuminuria or heart disease The abdomen was distended Ten teeth had erupted

The child had been given rice pap which was offered twice daily Usually two or three stools containing much undigested starch (detected microscopically) were passed daily, and the weight remained stationary The child would only take about half of the rice pap considered normal for one of her age and resented being fed The *appetite was poor and mental apathy persisted*

Skimmed milk powder [3 oz in one pint of water (150 g in 1 litre)] was started on 16 11 52 Within a day or two the child lost all the oedema, the weight fell from 12 lb 12 oz to 12 lb 7½ oz (5 78 to 5 65 kg) and then rose to 13 lb 6 oz (6 07 kg) by the day of the demonstration

which had begun three weeks previously with dyspigmentation and gastro-intestinal trouble At the time of the patient's admission, clinical examination showed pronounced apathy, irritability, and marked oedema on the lower limbs and the face The head-hair, the eyebrows, and the pubic hair were completely discoloured The liver and spleen were slightly enlarged The blood test showed slight macrocytic and hyperchromic anaemia, 3,910,000 red blood cells, haemoglobin 91 per cent, haematocrit reading 38, mean corpuscular volume 103 The blood serum contained 4 40g total protein per 100ml [1 75g albumin and 2 65g globulin (α 0 30, β 0 97, γ 1 58)]

Both cases were therefore examples of kwashiorkor occurring during the breast feeding period and probably caused by exhaustion

BED FOR METABOLIC STUDIES

(in use in Medical Research Council research ward)

by

B S Platt

Professor PLATT demonstrated the use of the simple bed available for metabolic studies (plate 2) at the Research Station, explaining that it had been in use for the last three or four years and had proved quite satisfactory The child could remain in it for three days at a time The bed had an orthopaedic metal frame, important from the point of view of keeping the knees down, and was adjustable for the collection of urine and faeces in covered receptacles A home-made cannula of fabric from silk stocking and X-ray film dissolved in acetone was fixed with elastic and padded for comfort He stated that the bed was not satisfactory for female children

Professor MONCRIEFF said that the problem of female children had been solved in London with the assistance of a dentist A plastic cast - in which antiseptic had been incorporated - of three or four standard sizes had been moulded so that it could be adjusted to fit children of all ages It could be used for periods up to 48 hours

Professor PLATT said that his own experiments with rubber moulds had not been very successful

LIVER BIOPSY DEMONSTRATIONS

by

J C Waterlow, H C Trowell and J N P Davies

Dr WATERLOW said that he could not compare one method with another, as he had experience only of one He wanted to emphasize that it was still possible to do a biopsy even when no special needle was available He used a trocar and cannula with a syringe

Dr RAO said he was confused about the question of kwashiorkor after hearing some of the earlier comments and after seeing the cases demonstrated, which seemed to him to be similar to those found in camps of destitutes in India and Burma the only difference being that no reddening of the hair had been noted in Asia He asked whether the skimmed milk powder was given for treatment when diarrhoea was present

Dr TROWELL replied that much depended on the type of kwashiorkor, if severe, it might be necessary to start with a special diet of skimmed milk powder and banana, mild cases could be more easily treated by adding skimmed milk powder in small amounts to the ordinary diet

A brief exchange of views took place between Dr TROWELL and Dr WATERLOW about the difficulty of studying kwashiorkor in Africa owing to the ever recurrent malaria pattern which complicated the picture Dr WATERLOW wished for more information concerning the effects of malaria and undernutrition on the production of the pancreatic enzymes

Dr CLEMENTS asked whether it could be assumed - in the absence of the dietary history of the mother - that the first case was one of undernutrition and the second one of mild or pre-kwashiorkor

Dr TROWELL, in reply, believed that it was possible in certain cases for underfeeding and protein deficiency to be combined, but that two main groups of cases were usually seen He said that the first case was definitely one of undernutrition, the second of kwashiorkor

Professor PLATT said that, in general, malnutrition seemed to be more severe in large towns than in bush villages Indeed, it was not entirely fortuitous that the florid forms of malnutrition in infants had been given more attention in the larger towns than in rural areas

Dr de MAEYER said that there were many descriptions of kwashiorkor among children at weaning age and during the years immediately following weaning What was much less known was that it might appear in the lactating mother He had recently seen in the Belgian Congo two cases which he would briefly describe

The first mother was 22 years old and five months previously had given birth to a child which she had breast fed On admission to hospital both mother and child showed the classical clinical signs of kwashiorkor, with dyspigmentation altered personality and oedema The symptoms had appeared some 15 days previously but it was not possible to tell whether they had appeared first in the child or in the mother

The second mother, aged 25 years, came to the hospital with an 18-months-old child who had been breast fed from birth and appeared undernourished The mother showed all the signs of kwashiorkor,

DISCUSSION

Dr RAO described some clinical observations on liver disease among children in India and Burma* He felt that some knowledge of clinical conditions of the liver occurring in children in parts of the world other than Africa might be of value to delegates in their work at the present Conference He was personally interested in the relation of liver disease to diet He had been troubled, in his early post-graduate days at a teaching hospital in southern India, by the ascription to chronic alcoholism of such a condition as ascites due to portal cirrhosis Subsequent investigation had shown that those conditions co-existed with a low protein diet and deficiency in vitamins, especially of the B-complex

He had studied cases of enlarged liver in children of one to three years The condition had been known by a number of different names, such as infantile cirrhosis and infantile biliary cirrhosis, but it evidently bore some relation to kwashiorkor as far as that age group was concerned The symptoms in the early stages were similar except for skin lesions Infants of nine months to one year were generally off their feed and suffered from either diarrhoea or constipation Slight enlargement of the liver and leucocytosis were present at that stage That, he thought, was a stage generally missed in observations of the disease The liver was definitely enlarged to the extent of two or three fingerbreadths but it was soft, there was associated sub-clinical jaundice Later, the liver hardened and there was even greater enlargement, the associated jaundice reached an advanced state The feet were swollen and ascites was present The infants died in a state of cholaemia

Delegates would see where the condition differed from that known to them as kwashiorkor It was found moreover among children coming from high income groups who would be expected normally to have had a sufficient protein intake, it might be, however, that religious and other customs governing dietary conditions accounted for the protein lack Observation tended to confirm that suggestion A survey of 1,000 children from lower income groups living on a low protein diet showed enlargement of the liver in 10 to 12 per cent of the cases, accompanied by pot-belly and clinical undernourishment There were no cases of oedema All were out-patients

Dr Rao said that further observations had been made among both children and adults suffering from malnutrition in the refugee camps in India in 1948 On the whole the condition of children living on sub-optimal diets had shown considerable similarity to that of children at present being treated at the MRC research station the nutritional status was poor, the feet were swollen and the skin was dry, and the presenting symptom was diarrhoea Other changes which occurred were attributable to vitamin A deficiency, with angular stomatitis and raw beefy tongue It could not at present be said

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* see also page 358

The liver is entered by the transpleural route, according to the method of Iversen[1] The child is previously given paraldehyde, either rectally or intramuscularly Either a general anaesthetic (ethyl chloride) or a local anaesthetic can be used The child lies on its left side A small incision is made in the eighth or ninth intercostal space, and the trocar and cannula inserted When the liver is reached the needle must be allowed to pivot freely on the chest wall, otherwise there will be danger of tearing the capsule The trocar and cannula are inserted into the liver to a depth of about 1 cm The trocar is then removed, the syringe attached, and the cannula pushed in a further 2 cm or so As the cannula is advanced into the liver suction is maintained with a syringe It is essential for success that during the operation the cannula should be rotated It is advisable to have an assistant to press the liver up against the diaphragm

In reply to questions, Dr Waterlow said that failures sometimes occurred when the operator was not sufficiently skilful he gave vitamin K before the biopsy as a routine

Dr TROWELL said that he had performed on children some 50 to 60 biopsies by the intercostal route but he pointed out that almost invariably he had found that the liver was being pushed forward and that blood collected in the syringe For that reason he was in favour of biopsies by the epigastric route using the Vim-Silverman needle, advancing in the right lobe of the liver by directing the needle upwards and outwards towards the mid-axilla

Professor DAVIES said that the pathologist needed a representative piece of the liver removed as quickly as possible with minimal trauma and distortion, and placed speedily in the appropriate fixative Surgical biopsy which removed a wedge-shaped piece of the capsule region was useless as it gave an unrepresentative picture of the liver and the specimen was frequently grossly abnormal when the rest of the liver was normal He distinguished between two types of liver biopsy, one for diagnosis and the other for the detailed study of morphologic changes He did not like the Vim-Silverman needle for the latter purpose as he found it was too 'whippy' and so sometimes deflected by fibrous tissue He suspected this when he found shreds of fibrous tissue at the edges of the specimen For research purposes he preferred the Gillman type of needle which gave a longer, larger thread and showed several lobules in cross section He favoured laying the thread of liver tissue on a glass slide for a few seconds before lowering the slide carefully into the fixative The thread stuck to the slide and could be carried through without distortion to preliminary embedding in wax

In reply to a question he said that he did not think that in Africans there were notable differences between the appearances of the right and left lobes of the liver

REFERENCE

1 **Iversen, P & Roholm K** *(1939) Acta med scand* , **102**, *1*

Clinical observations had been supported by the following findings

(a) hypoproteinaemia, with inversion of the albumin globulin ratio
(b) diminution of pancreatic enzymes in the duodenal secretions
(c) enlargement and fatty infiltration of the liver without cirrhosis or necrosis (plates 13, 14)
(d) the pancreas showed oedema rather than fibrosis, with a marked diminution of zymogen granules (plates 15, 16) It was also evident that the usual autolytic phenomena were less evident than in the normal conditions

Further, he said, he had endeavoured to delimit the essential part of the syndrome and to separate it from the different known avitaminoses which often occurred with it, and complicated the picture This was particularly so in the case of deficiency of the vitamin B-complex, the absorption of which might be impaired as a result of chemical competition in the process of phosphorylation by the increased absorption of carbohydrates Symptoms of ariboflavinosis subsided a few days after treatment with riboflavin

Beriberi with a 'shoshin'-like heart syndrome and with electrocardiographic changes could be cleared up in 24 to 48 hours giving thiamine (plates 9, 10), or a still shorter time by injecting cocarboxylase The latter procedure was useful as an urgent measure in severe cases when plasma transfusion was required, this otherwise might cause death by raising the arterial pressure

The pellagrous skin lesions found simultaneously with starchy food dystrophy, especially a bullous or pemphigoid form, quickly disappeared on treatment with nicotinamide (plates 7, 8) On this evidence he thought it inaccurate to identify starchy food dystrophy with infantile pellagra as some authors had done for kwashiorkor His experience had been that infantile pellagra, like pellagra in general (in its classical form as described by Italian authors two centuries ago), could be eliminated in its entirety by the addition of nicotinamide to a pellagragenic diet On the other hand, however, nicotinamide given in high doses in cases of kwashiorkor was harmful, causing increased liver damage, as the Gillmans[1] had shown That could be understood because nicotinamide must be methylated before being eliminated

The experiment of giving single vitamin B-complex factors in clinical cases of starchy food dystrophy without modifying the original diet had enabled him to isolate the central or essential characteristics of the disease, as these were unaffected by the procedure These characteristics were oedema, hydrolability, fatty degeneration of the liver and diminution of the pancreatic enzymes, all of which might be attributed to protein deficiency as they disappeared on treatment with animal protein

whether these conditions could be designated by the term 'kwashiorkor', so far as it had been defined

Dr Rao had also had an opportunity to conduct a survey of nutritional deficiencies in population groups in Burma, including refugees in the towns Cases of malnutrition in children were commonly seen in hospitals The clinical signs were comparable with those of kwashiorkor, i e a miserable expression, enlargement of the liver, poor nutritional status, oedema of the feet, depigmentation of the hair which became dry and brittle and definitely discoloured, and a history of diarrhoea An exact diagnosis of the disease could not be made, it was perhaps kwashiorkor, but it might be marasmus or related disease All showed similar symptoms in the early stages although they differed later

It was clear that in India and Burma two distinct types of liver lesion existed, necrosis and fatty infiltration, both leading eventually to fibrosis However, until kwashiorkor had been defined in all its aspects, it would be impossible to say whether the disease as described in Africa existed in India and Burma It might be that a new syndrome would emerge, common to all countries where malnutrition, poverty and ignorance prevailed

Professor FRONTALI said that in parts of Europe, including Italy, a disease of infants at the post-weaning stage, similar in many respects to that which had been described by medical scientists working among African children, was known as 'starchy food dystrophy' This condition had been well known for about 40 years and occurred when infants were fed predominantly on paps of bread or maize flour with or without the addition of olive oil He felt that a description of the analogies and differences between this condition and kwashiorkor might be useful in a discussion of the clinical aspects of the problem

A survey of Italy, both peninsular and insular, carried out under his direction by the Centre for Studies on Child Nutrition of the Italian National Research Council, had shown that from 4 0 to 4 3 per cent of children in early infancy examined in Calabria and Sicily in 1949 showed starchy food dystrophy, whereas in North Italy the incidence was not higher than 0 45 per cent

Oedema, either general or localized was an outstanding symptom (plates 3 4, 5, 6) In some cases, from the areas where maize flour was common in the diet, signs and symptoms of pellagra were also evident (plates 7, 8) Several cases showed symptoms of beriberi with polyneuritis and cardiac signs, accompanied by electrocardiographic changes (plates 9 10)

Skin and hair manifestations were not frequent in European children and dyspigmentation of the skin tended to be hyper- rather than hypo-, although hypo-pigmentation occurred in certain cases hair was thin brittle, reddish or pale, and could be easily pulled out (plate 11) Occasionally, a condition approaching the so-called 'mosaic' pattern appeared on the skin (plate 12)

products On the whole it diverged little from kwashiorkor except with regard to the intensity of pigmentary changes

Dr PATWARDHAN said that his principal interest was in the aetiology of the disease The dietary factor had been rightly stressed, but wherein lay the deficiency said to be responsible for the disease? Was it purely a case of undernourishment? The view had been expressed that the root cause lay in the disparity between total calorie intake and the intake of calories from protein That, he thought, was an over-simplification Experimental work on monkeys had shown that not only the disparity between total calorie and protein calorie intake but also a deficiency in both protein and calories led to an early onset of oedema It appeared that there existed some other factors, the importance of which was not fully appreciated, which were liable to precipitate the disease in certain cases

The theory had earlier been held, and subsequent research had appeared at first to confirm it, that the development of the disease was due to parasitic infestation The idea, propounded by Dr Trowell in 1949, was attractive, but had not held ground against later observations which clearly showed that the disease could develop in the absence of both infection and infestation

The problem remained, therefore, and was of particular moment in tropical regions, it was essential to know the aetiology of the disease in order to be able to take adequate preventive measures As in Jamaica, comparative studies have been made of the dietary regimes of families with and without kwashiorkor, and significant differences were noted It had been found that the total calorie and protein intake was lower in children showing symptoms of kwashiorkor than in apparently healthy children It might be true that the aetiology was wholly dietary, but it was too early yet, he maintained, to limit attention to the disparity between protein calorie intake and the total calorie intake Other factors should not be left out of account If the cause were protein deficiency alone, pure protein hydrolysates would be sufficient to effect a complete cure That was not so Pure protein hydrolysates had proved less effective than skimmed milk He concluded, therefore, that a great deal more study and research was needed before definite conclusions could be reached In that matter India looked to Africa for a lead

In answer to a question from the Sessional Chairman Dr Patwardhan confirmed that the monkeys concerned in the experimental work he had mentioned had been fully grown He agreed that a distinction must be made between the development of the effects of calorie and protein deficiency in adults and young, and said that further work was in progress

Dr WATERLOW said that there seemed to him to be a fallacy in Dr Trowell's argument Dr Trowell had said that kwashiorkor was a result of relative protein deficiency, that that deficiency was widespread, if not universal, in Africa, and that therefore

He suggested that his colleagues in Africa should carry out a similar clinical analysis of the symptoms of kwashiorkor

Professor BROCK wished to remark upon the confusion which had been referred to by various speakers Those who were confused were so because they were looking for the exact definition proper to a recognized disease

In their work two years earlier - and they had found no reason to retract any statement made then - Dr Autret and he had used the term 'kwashiorkor' for a condition found in children of the post-weaning age group in the African continent 'Kwashiorkor' in its original clinical sense signified a disease spectrum and not a specific disease No one item in the spectrum was essential or diagnostic The term 'kwashiorkor', therefore, was not susceptible of precise definition

The condition, nevertheless, demanded attention as a symptom of a widespread social evil the failure to produce and use protein food of good quality in sufficient quantity, particularly for children in the post-weaning stage To the question whether the word 'kwashiorkor' was suitable to define the clinical condition, he thought the answer was 'yes' so far as it concerned the pigmented peoples of the African continent While focusing attention on the dyspigmentation, the term did not prejudge questions of aetiology or pathogenesis He agreed with Professor Frontali, however, that the advisability of the use of the term 'kwashiorkor' was questionable among European populations

To the further question whether there was any sign peculiar to kwashiorkor, he thought the answer was 'no' The nearest perhaps was the dyspigmentation with which the etymology of the word was linked, the most accurate term for the dyspigmentation of the hair would be dyschromotrichosis The Gambia furnished examples of dyschromotrichosis both with and without kwashiorkor

As for the expressions 'mild' and 'pre' kwashiorkor, he thought them inexact in view of the fact that the term 'kwashiorkor' was intended to indicate a disease spectrum The spectrum only became recognizable where its components occurred in sufficient intensity and in suitable combination He had, however, no doubt that for every case of recognizable kwashiorkor in a community there existed large numbers of cases of a milder deficiency state which might evolve into kwashiorkor given the appropriate stimuli or if dietary correction were not applied

Although the contributory factors were numerous, the essential aetiology was dietary and the condition could be produced by dietary deficiency alone In Capetown the syndrome lay somewhere between that of kwashiorkor and that of the starchy food dystrophy or mehlnährschaden Its aetiology was mainly dietary and not parasitic Dyschromotrichosis was present The children affected were at the post-weaning age and had been fed on a diet which included wheaten

known, that seemed to him immaterial he was content to know that he could recognize the disease when he saw it

Dr TROWELL wished to associate himself with the remarks made by Professor Davies and Professor Frontali He too felt that there were certain symptoms which were so constant as to be easily acceptable as pointers to the presence of this disease Beyond them there was indeed a wide range of other variable signs, but that should not evoke surprise in view of various associated vitamin deficiencies and of the different dietary conditions prevailing in different parts of the world, as for instance rice eating in India and wheat eating in South Africa He was convinced that when children aged between one and two years had ceased to grow and were passing large bulky stools they often responded favourably to treatment with protein

Dr AUTRET, referring to the question of the adoption or rejection of the term 'kwashiorkor', said that in his opinion it was too early to reach a final decision on nomenclature, that it was necessary first to agree on a clear definition of the clinical signs of the disease, to listen to biochemical and physiological discussions and to study the treatment and the dietary factors involved Dr Autret pointed out that in any case the term 'kwashiorkor' suggested only one clinical sign, other terms used in different areas of Africa suggested different signs, such as coldness of the hands and feet On the other hand, it was not because the term, which recalled the concept of dyspigmentation, did not apply to all cases in the world that it should be rejected Several names of diseases existed which did not recall their etymology However, the Latin American authors seemed, during the 1951 mission on protein deficiency syndromes in Central America, very reluctant to accept such a name

Dr CLEMENTS thought that Dr Trowell had raised an important point with regard to infant nutrition in general If children between one and two years who failed to put on weight were to be regarded as actual or potential victims of kwashiorkor, then the concept must be extended to include the advanced as well as the backward countries In Melanesia there was no condition corresponding to the type commonly found in Africa which showed dyspigmentation pot-belly and enlargement of the liver Nevertheless, there was a condition in which the weight curve followed a course identical with that given for kwashiorkor, that was to say, it rose normally for the first six to eight months of life and then flattened out When protein or calorie treatment was given, growth recommenced The problem arose then whether children suffering from arrested growth and responding to protein treatment should be regarded as cases of kwashiorkor or pre-kwashiorkor It was, he felt, one which the Conference should consider

Professor BROCK wished to correct a misunderstanding he intended in no wise to retract anything he and Dr Autret had said two years earlier In general he agreed with the clinical findings

kwashiorkor was universal   It was not the facts which were in dispute, but the emphasis, the fallacy lay in the 'therefore' Professor Brock had spoken of the disease spectrum, it was clearly impossible to draw any hard and fast line beyond which kwashiorkor might be found   Nor was that important, the aim ought to be to find the exact cause of the many different manifestations of the disease   To subsume all those differences under a single word was to diminish the value of the concept   The widening of the concept, largely through the work of Dr Trowell, had done much good, but the time had arrived for analysis   He would therefore make a plea to retain the word 'kwashiorkor' for the clinical picture so vividly described by Cicely Williams[2], and to find a second and more general term to cover other manifestations of the disease   Lastly, to assume that the word 'kwashiorkor' had a precise and well-defined meaning was to invite confusion   The Conference should urge all those publishing material on the subject to give full details of the facts observed, so that the reader might judge for himself whether or not cases described were examples of kwashiorkor

Dr HAWE felt that little practical progress could be made by describing the disease as a spectrum   What was required was a guide to doctors practising in Africa in spotting the disease where it existed   Similarly he thought it a mistake to deny the existence of mild cases   They occurred and were curable   But they were not so easily diagnosed as the advanced cases with their characteristic pigmentary and other changes   It was more important therefore to give help to practising doctors in picking them out

He had not previously had any knowledge of the disease in Uganda or Italy but what Dr Trowell and Professor Frontali had described appeared to him to bear a striking resemblance to what he had observed in the Gold Coast   It was difficult to lay down an exact diagnosis but it was clear that the condition was quite distinct from that of general starvation   In the latter case it was simply a matter of a failure in food supply   In kwashiorkor, however, there was a distinct alteration in the manner in which the food supplied was assimilated   It was along those lines he felt, that work should proceed in order to give the general practitioner a clear diagnosis from which to work and upon which to base a rational treatment of the disease

Professor DAVIES agreed with Dr Hawe that there was in fact a clearly recognizable central group of symptoms which, clinically, pathologically and biochemically, showed the same response to treatment   He agreed that not every case could be neatly classified, but submitted that demands should not be made of the concept kwashiorkor which were not made of other disease concepts   It was not possible to snapshot a disease   a disease was a course of events, a continuing process, a series of changes, within, however a recognizable overall pattern   Treatment of children for kwashiorkor might, by sheer chance, begin at any stage in the development of the disease   If the original diet had been maintained under observation all the remaining stages of the disease would have become apparent   As for the name by which it was to be

Chairman Professor F. J. C. Cambournac

INTRODUCTORY STATEMENT ON THE PATHOLOGY OF KWASHIORKOR

by

J. N P Davies

I cannot here deal with all the aspects of the pathology of kwashiorkor and shall concentrate on what I believe to be the important ones, particularly those which I regard as distinctive. I believe that kwashiorkor is a specific entity with a distinctive and constant pathology, and would stress that long before there are changes which can be demonstrated by the relatively crude methods of histology, there are biochemical changes which can give rise to a mild or pre-kwashiorkor state. The important change is a diminution of the pancreatic enzymes. I believe that the basic histological lesion is a specific atrophy of the enzyme secreting cells with a failure to form zymogen granules, maximal in the pancreas (plate 17) and small intestine, which have the highest rates of protein turnover, but also occurring in the salivary and lachrymal glands. It is possible that atrophic changes in the muscle may be detected at an even earlier stage if muscle protein is called on for enzyme building. The gross pictures of pancreatic atrophy are seen in the extreme cases but they can be obscured by quite moderate improvement in the diet. Unless this is borne in mind the atrophy of the acinar glands can be easily missed No case of kwashiorkor without these lesions has been encountered and this histological change is in conformity with the low levels of pancreatic enzymes in the duodenal juice as shown by intubation studies. On the feeding of a high protein diet the degree of atrophy diminishes rapidly and the enzyme levels in the duodenum rise Similar selective atrophic changes take place in the salivary glands, especially the parotid, and in the lachrymal glands (plate 18) Eye changes in kwashiorkor cannot be accepted as specific of vitamin deficiency states unless the functional and structural integrity of the lachrymal gland is established.

At autopsy florid cases of kwashiorkor presented as plump children with, over the trunk and legs, a layer of subcutaneous fat a centimetre or more thick. The liver was yellow with fat and the pancreas grossly atrophic. By contrast, in undernutrition, starvation, or marasmus there was little or no subcutaneous fat, little or no fat in the liver and no selective atrophy of, or loss of enzymes from, the enzyme-secreting glands Florid cases of kwashiorkor can and do pass into a marasmus-like state (infrequently in Uganda but more frequently in South Africa) but such cases can be differentiated from those of pure starvation on pathological grounds.

The changes in the liver, unlike those in the pancreas, were variable The fat infiltration, while universally seen in the

of Dr Trowell, Professor Davies, and others The group of special cases found among the Cape Coloured people in Capetown, to which he had referred (see page 104), lay, so to speak, on the outskirts of kwashiorkor as seen in Central Africa There was no tropical parasitism and wheat was the basic product consumed Kwashiorkor among the maize eating Bantu people of South Africa was not distinguishable from the Central African variety, except in the absence of tropical parasitism

REFERENCES

1 Gillman, T & Gillman, J *(1946) Lancet,* ii, *446*

2 Williams, C D *(1933) Arch Dis Childh* , 8, *423*

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At autopsy florid cases of kwashiorkor presented as plump children with, over the trunk and legs, a layer of subcutaneous fat a centimetre or more thick. The liver was yellow with fat and the pancreas grossly atrophic. By contrast, in undernutrition, starvation, or marasmus there was little or no subcutaneous fat little or no fat in the liver and no selective atrophy of, or loss of enzymes from, the enzyme-secreting glands. Florid cases of kwashiorkor can and do pass into a marasmus-like state (infrequently in Uganda but more frequently in South Africa) but such cases can be differentiated from those of pure starvation on pathological grounds.

The changes in the liver, unlike those in the pancreas, were variable The fat infiltration, while universally seen in the

severe florid stage, was a transient phenomenon. When autopsies were performed on children of, say, ten months who had only been in the early stages of the disease, marked pancreatic atrophy was found, and in the liver minimal or moderate peripheral fat infiltration and no fibrosis were seen. In the florid stages, say at the age of 18 months, pancreatic atrophy, gross fatty infiltration of the liver and increasing fibrosis were found. Later, diminishing amounts of fat were found and, at say 5 years, cases were seen with pancreatic atrophy, and little or no fat in the liver but with an increased amount of fibrosis. There were thus varying pictures to be seen in the liver forming a regular sequence, but to say that there can be a case of kwashiorkor with no fat in the liver is not to say that there never has been fat in the liver (plates 19, 20).

The fat in the liver always appeared first at the periphery of the lobule and increased towards the centrilobular region till the whole lobule was full of fat. It retreated from the centre and lastly from the periphery. If in a case of kwashiorkor the fat was not initially at the periphery of the lobule, then an infective process, often tuberculosis, was present. With the appearance of the fat there was a filling of the portal triads with reticulo-endothelial cells, lymphocytes and plasma cells, and thickening and collagenization of the reticulin fibres which disorganized the lamina limitans and resulted in a star-shaped scar with radiating fibres tending to join neighbouring portal triads and thus to delimit the liver lobules. This stellate fibrosis is thought to be the indicator of a past episode of fatty infiltration as it started with and developed concurrently with the fatty infiltration, but I want to emphasize that I have never believed that the development of the fibrosis was due to the fat.

In conclusion I must reiterate my conviction that kwashiorkor is a disease with a distinctive and specific pathology. In marasmus there is no subcutaneous fat, little or no liver fat and no selective enzyme secreting cell atrophy, the pancreas being normal. In acute infections, intoxications and gastro-enteritis, fatty livers do occur, the fat is often centrilobular and is a terminal phenomenon in a stormy and turbulent illness and the pancreas is unaffected. Only in mehlnahrschaden, kwashiorkor and starch dystrophy - which I regard as identical conditions - is there the combination of persisting enzyme-secreting cell atrophy with prolonged fatty liver infiltration

I should like to thank Mr T. N Salthouse, A.B I P A R.P.S for taking the photographs.

HISTOPATHOLOGY OF THE CUTANEOUS LESIONS OF KWASHIORKOR

by

H. Berte

The cutaneous changes in kwashiorkor exhibit all the macroscopic and microscopic features of a dermo-epidermitis which may be erythematous, erosive or exfoliating, according to the stage under consideration. The interest of a histological study of these lesions lies in the fact that, although there is no characteristic picture, it enables one to demonstrate a relationship between the different clinical aspects of this disorder and provides a firm basis for making a differential diagnosis. It is from this point of view that I intend to study in turn the dry, the weeping, and the exfoliating lesions of kwashiorkor Several common features are evident beneath a multiformity more apparent than real.

Dermal Lesions (plates 21, 22, 23a, 23b)

Throughout the whole of its depth the dermis appears to be infiltrated with copious serum which separates the collagen bundles, forming gaps between them These gaps lie parallel to each other and are so numerous and extensive that the tissue appears spongy and extremely delicate (plate 21) In the neighbourhood of the vessels of the subpapillary network the connective tissue fibres are distended by oedema This causes the vessels to be isolated in the centre of a clear enclosed space and makes evident the dilatation of their lumen, the stasis of blood flow and the swelling of the endothelial cells

In the papillary bodies and the papillae which have been swollen by oedema, an abundant serous exudate forms pools beneath the epidermis, causing areas of detachment of the stratum basale or complete disorganization of this layer. The distension of the connective tissue shows the cells there to be fixed, rounded and hypertrophied.

The dermis is, moreover, invaded by a cellular infiltrate This is particularly dense round the vessels where it forms a cuff along their course, and in the neighbourhood of the sweat glands Elsewhere it is distributed uniformly throughout the whole thickness of the dermis It consists almost entirely of lymphocytes and small mononuclear cells Neither polymorphs nor large macrophages are found there occasionally there are a few fibroblasts

Epidermal Lesions

The extent of the epidermal involvement distinguishes the different types of kwashiorkor.

Dry lesions (plate 24) are found at the onset of the disorder. They consist of infiltrated erythematous macules. Epidermal involvement is minimal, consisting merely of uniform thinning, or, more

frequently, of considerable irregularity in epidermal thickness The dermal papillae are frequently enlarged, with a dome-shaped depression at their apex Above them the epidermis is reduced to a slender basal layer surmounted by not more than one or two layers of flattened cells. Its thinness at this level contrasts with the hypertrophied interpapillary bodies which are increased in every dimension and consist of ten or twelve layers of polygonal cells. Although there are numerous mitoses the normal cellular relationship is maintained, and the intercellular spaces and bridges can be seen. There is no infiltration of serum or cells, but there is what appears to be a simple reactionary acanthosis The granular layer is usually present, but interrupted, and seldom consists of more than one layer of cells The horny layer is usually absent

Weeping and exfoliating lesions (plate 25) Histologically, these lesions reflect to some degree the changes of the particular stage in the epidermal disorder. Here the epidermis is always very irregular in depth, areas of extreme aplasia alternating with arears of considerable acanthosis The stratum germinativum is formed of cubical rather than cylindrical cells they are actively proliferating and form several layers where numerous mitoses may be seen. In places this layer is separated and disorganized by the spongiosis so that it loses its continuity and parts of it are cut off and mixed with the cells of the underlying infiltrate

Above the stratum basale, the Malpighian layer, where it is present, appears increased in depth owing to the great number of cellular layers and the size of the individual cells It does not take the ordinary stains well and is pale when stained This is undoubtedly the result of histochemical changes secondary to the oedema There is, in fact, impregnation throughout with fluid the intercellular spaces are distended, in places there is intra-cellular oedema and there are pockets of foam At these sites the granular layer is absent and there is parakeratosis and exfoliation. The oedema forms a cleft in the superficial layers of the Malpighian stratum, which are split off and exfoliated. A small quantity of their fluid is sometimes carried away in a cavity lying between their cells. The elimination of quantities of these intra-epidermal bullae, which have no chance to reach the surface, is evidence of the abundance of the oedema, the intensity of the spongiosis, and the activity of the epidermal reaction, and this is also shown in the exuberant and irregular development of the interpapillary bodies at the edges of the lesions.

Chronic weeping lesions (plate 26) After a certain time, the exfoliation ceases and the lesion of kwashiorkor develops as a macule with an abraded surface from which abundant fluid exudes Macroscopical examination shows oedema throughout the whole of the Malpighian stratum, the cells of which are clear, round, and pressed together without any intercellular spaces Intra-epidermal vesicles are found here in places and there are small collections of intercellular fluid. The granular and horny layers have completely disappeared

Lesions of the Hair (plate 27)

In a slide of the scalp, the hair follicles, hair roots and shafts show a normal histology Preparations of hairs mounted in glycerin or lactophenol show no particular structural abnormality Among the specimens sent to us for examination were many dead hairs, and thin ones which were very likely replacement hairs. The other hairs were always finer than usual, curled up in spirals, and they behaved like coiled springs This tendency is the result of variation in the activity of the papillae at the time when the oedema develops in the dermis, coupled with a variable fluid pressure

Differential Diagnosis

When the complete picture of kwashiorkor is considered, histological study slightly reduces the significance of the cutaneous lesions which are clinically of primary importance The changes described would, in fact appear to be the result of the pressure in the dermis of the oedema, which is greater than is found in the majority of skin diseases

In this respect one might compare the cutaneous changes of kwashiorkor with those of erythrodermia, which are clinically similar. But one does not find in the histology of kwashiorkor the intense and irregular proliferation of the papillary bodies, the frequent hyaline bodies at the level of the dermo-epidermal junction, the migration of the pigment which invades the dermis in the form of isolated masses or inclusions within the macrophages Finally, in erythrodermia a few polymorphs and eosinophils intermingle with the histocytes and lymphocytes of the infiltrate

The hypertrophy of the Malpighian stratum, the enlargement of the papillae, their dome-shaped depression and the cleavage between dermis and epidermis might make one think of lichen planus, particularly as this condition may give rise to a true erythrodermia In lichen planus, however, the granular layer is always present and is frequently hypertrophied and covered by a thick, horny layer, whereas it is frequently absent in kwashiorkor Besides, the dermal infiltrate is denser in lichen planus, and is situated in the papillary body and the superficial part of the corium while its lower limit is always clearly defined

It might perhaps, seem paradoxical to suggest a likeness between psoriasis and kwashiorkor, but their histology shows many common features parakeratosis with shedding of fine scales, absence of granular layer, acanthosis, and gaps within the epidermis recalling the micro-abscesses of Munro Kwashiorkor is distinguishable by the prominence of the cellular infiltrate and the dermal oedema, the absence of papilloma formation and the presence of intra-epidermal oedema Besides, this diagnosis would not be made clinically, and is mentioned here merely to provide a comparison with which to illustrate my description

frequently, of considerable irregularity in epidermal thickness The dermal papillae are frequently enlarged, with a dome-shaped depression at their apex Above them the epidermis is reduced to a slender basal layer surmounted by not more than one or two layers of flattened cells. Its thinness at this level contrasts with the hypertrophied interpapillary bodies which are increased in every dimension and consist of ten or twelve layers of polygonal cells Although there are numerous mitoses the normal cellular relationship is maintained, and the intercellular spaces and bridges can be seen. There is no infiltration of serum or cells, but there is what appears to be a simple reactionary acanthosis The granular layer is usually present, but interrupted, and seldom consists of more than one layer of cells. The horny layer is usually absent.

Weeping and exfoliating lesions (plate 25) Histologically these lesions reflect to some degree the changes of the particular stage in the epidermal disorder Here the epidermis is always very irregular in depth, areas of extreme aplasia alternating with arears of considerable acanthosis The stratum germinativum is formed of cubical rather than cylindrical cells, they are actively proliferating and form several layers where numerous mitoses may be seen. In places this layer is separated and disorganized by the spongiosis so that it loses its continuity and parts of it are cut off and mixed with the cells of the underlying infiltrate

Above the stratum basale, the Malpighian layer, where it is present, appears increased in depth owing to the great number of cellular layers and the size of the individual cells It does not take the ordinary stains well and is pale when stained This is undoubtedly the result of histochemical changes secondary to the oedema There is, in fact, impregnation throughout with fluid the intercellular spaces are distended, in places there is intracellular oedema and there are pockets of foam At these sites the granular layer is absent and there is parakeratosis and exfoliation The oedema forms a cleft in the superficial layers of the Malpighian stratum, which are split off and exfoliated A small quantity of their fluid is sometimes carried away in a cavity lying between their cells. The elimination of quantities of these intra-epidermal bullae, which have no chance to reach the surface is evidence of the abundance of the oedema, the intensity of the spongiosis, and the activity of the epidermal reaction, and this is also shown in the exuberant and irregular development of the interpapillary bodies at the edges of the lesions

Chronic weeping lesions (plate 26) After a certain time, the exfoliation ceases and the lesion of kwashiorkor develops as a macule with an abraded surface from which abundant fluid exudes Macroscopical examination shows oedema throughout the whole of the Malpighian stratum, the cells of which are clear, round, and pressed together without any intercellular spaces Intra-epidermal vesicles are found here in places and there are small collections of intercellular fluid The granular and horny layers have completely disappeared

HAEMOSIDEROSIS IN THE GOLD COAST AFRICAN

by

G. H. Edington

The significance of the presence of large amounts of histochemically demonstrable iron in the liver cells and tissues of man is not at present fully understood. Gillman and Gillman[7] noted that this abnormality was present in 88 6 per cent of adult African livers in South Africa. They considered that this increase in the iron content of the liver was one of the stigmata of malnutrition imposed by a predominantly maize meal diet. Walker and Arvidsson[13] considered that the high iron content of the Bantu diet was an aetiological factor in causing the haemochromatosis so common in that race. Davies and Trowell[3], however, could find no haemosiderosis in Uganda although malnutrition was widespread, a maize diet was eaten, and iron cooking pots were used. They stated that the iron content of the diet had not been estimated and that the presence of much iron in the diet was, therefore, presumptive only, on the evidence available they inferred that haemosiderosis was probably rare in East Africa, French West Africa and Nigeria. The Gillmans considered that the severe anaemia and bilharzia infestation found in Uganda probably explained the absence of haemosiderosis in that country. Waterlow[14] also noted an increased iron content of the liver in fatty liver disease in the West Indies

The various factors which have been implicated in the aetiology of haemosiderosis are

(a) an inborn error of metabolism[10]
(b) malnutrition plus a high iron intake in the diet[13]
(c) pyridoxine deficiency in the presence of an adequate amount of dietary iron[6]
(d) cobalt deficiency in cattle and sheep[6]
(e) deficiency of the pancreatic enzymes[11,12]
(f) absence of copper[14]
(g) a low phosphate content of the diet.

The livers of 251 Gold Coast Africans who had died from any cause have been examined for the presence of histochemically demonstrable iron. The simple hydrochloric acid - potassium ferrocyanide method (Perl's) was used to detect the presence of iron in formalin fixed, paraffin embedded sections. Only those sections of liver resembling the type II (plate 28) and III (plate 29) livers described by the Gillmans[7] have been recorded as iron containing. The type II liver contains granules of iron pigment in the periportal hepatic cells and a little iron may be present in the Kupffer cells The type III liver contains iron pigment in the hepatic and Kupffer cells, and masses of pigment can be seen in the portal tracts.

The same cannot be said for the differential diagnosis between kwashiorkor and the eczemas, vesicular, weeping and scaling, the eczematides, and pemphigus, which can affect subjects of the same age

Vesicular eczema is easily distinguishable by the preservation of the granular and horny layers and by the presence within the epidermis of small primary vesicles and numerous larger vesicles reaching up to the cutaneous surface.

The differential diagnosis from weeping and scaling eczema and the eczematides is more difficult

In **weeping eczema**, neither the granular nor the horny layer is found, and oedema of the dermis and epidermis is considerable There are also numerous pockets of spongiosis, but instead of the superficial layers being split off from the epidermis by the oedema, these pockets are opened up to the exterior by the collapse of their roofs and the formation of vertical chimneys known as the 'wells' of Devergie

Scaling eczema and the eczematides are, like kwashiorkor, associated with acanthosis and parakeratosis with exfoliation, but the Malpighian layer is thicker than in kwashiorkor and the oedema and pockets of spongiosis are absent, the serous and cellular infiltrates are also much reduced

The cleavage of the layers of the epidermis suggests the process of formation of the **pemphigus** bulla, but in the latter condition the cleft enlarges to form a more extensive cavity The zones of cleavage in kwashiorkor are multiple, of small dimensions and more superficial than those which give rise to the primary lesion of pemphigus Moreover, the subjacent dermal infiltrate of the pemphigus bulla is always rich in polymorphs.

Conclusion

The histological picture of the cutaneous lesions of kwashiorkor, without being absolutely characteristic, presents enough specific features to support a clinical diagnosis and, in doubtful cases, to exclude conditions which show some clinical similarities to kwashiorkor.

While emphasizing the part played by the dermal oedema and the movement of the epidermal oedema which is first intercellular, then intracellular, this study gives an explanation of the desquamation without excluding the possibility of a more fundamental systemic factor, or of a more complex disturbance of keratin formation

Table I

The incidence in age and sex groups of the occurrence of iron pigment in the livers of 251 Africans

Age groups	MALES					FEMALFS				
	Total	No pigment	Types II	Types III	Types IV	Total	No pigment	Types II	Types III	Types IV
New-born	19	6	10	3		11	5	5	1	
Under 5 years	17	14	3			19	17	2		
6 - 15 "	9	9				6	4	1	1	
16 - 25 "	29	23	5	1		27	21	5	1	
26 - 35 "	32	17	8	2	5	16	15	1		
36 - 45 "	31	19	4	3	5	15	10	3	1	1
46 - 55 "	10	6	2	1	1					
Over 55 "	9	3	2	2	2	1				1
Total	156	97	34	12	13	95	72	17	4	2

The type IV (plate 30) liver exhibits cirrhosis with a varying amount of iron pigment either of the type II or III distribution. Of the 251 livers examined 82 were of the type II, III or IV described above, an incidence of 33 per cent It must be remembered, however, that no specialized techniques were employed to detect the presence of iron in the tissues so this figure is not directly comparable with those of other authors. The results are given in table 1.

The distribution of iron pigment in the new-born differed from that of the adult in that a greater amount of pigment was contained in the Kupffer cells and less in the liver cells. (It is of interest to note that severe fatty infiltration of the liver is a common pathological finding in the new-born baby in the Gold Coast) Another common finding at autopsy is the presence of marked jaundice, much iron pigment in the liver and spleen with the distribution as found in haemolytic anaemia and areas of extramedullary erythropoiesis in the liver and spleen. The aetiology of this last condition is an interesting problem when it is remembered that the incidence of rhesus negative individuals in the Gold Coast is in the region of 4 per cent[4]. It should also be stated that the erythrocytes in a number of these infants have not sickled.

The causes of death in the subjects with type II and III livers did not differ from the causes of death in those exhibiting no pigment. Seven of the 97 males and two of the 72 females with no demonstrable iron pigment in the liver cells were suffering from cirrhosis of the liver and in three of the males carcinomatous change was present The livers of five children suffering from kwashiorkor and ten from malaria did not contain iron pigment. The livers of three grossly malnourished males and two females suffering from beriberi and pellagra respectively were also free of iron pigment. In only one instance (plate 31) was iron pigment detected in the pancreas, and that was in an adult male aged 36 who was considered to be suffering from haemochromatosis

Discussion

The staple foodstuffs in the Southern Gold Coast are cassava and maize Accurate figures are lacking but the diet is generally considered to be deficient in protein Iron cooking utensils were used in 53 of the 78 households surveyed by Mrs F Grant when investigating the dietary components of villagers in the Gold Coast. Signs of malnutrition are relatively common in the population, the incidence of these signs being highest in children and women of child-bearing age[1] Table 2 illustrates the incidence of various conditions found in 255 'healthy' villagers in the Southern Gold Coast[1], and 200 Accra schoolchildren of well-to-do parents - probably the healthiest children to be found in the Gold Coast[5]

conditioned to this increased absorption of iron with consequent lowering of the threshold value. Thus, when immunity or tolerance to the parasitic infestations is reached in adult life, relatively large amounts of iron may continue to be absorbed and as there is little increased utilization, and loss of iron via parasites does not occur to the same extent as in childhood, the iron accumulates in the organs with consequent haemosiderosis.

This theory of the conditioned lowered threshold would account for the finding that haemosiderosis is apparently a common and fortuitous occurrence in the Gold Coast African and is not linked specifically with any condition. It is concluded that in the Southern Gold Coast haemosiderosis is of little importance in the nursing mother or in the pathology of kwashiorkor.

REFERENCES

1 Colbourne, H. J., Edington, G. M & Hughes, M. H. *(1950) Trans R Soc trop Med Hyg*, 44, 271

2 Dacie, J V. *(1950) Practical Haematology* *Churchill, London*

3 Davies, J N P & Trowell, H C *(1951) Brit med J*, 1, 1514

4 Edington, G M *(1951) Ann Report Med Res Inst, Accra*

5 Edington, G M, Hughes, M. H. & Sarkies, J. W. R *(1950) Unpublished data*

6 Follis, R H. *(1948) The Pathology of Nutritional Disease, Blackwell, Oxford*

7 Gillman, J & Gillman, T *(1951) Perspectives in Human Malnutrition, Grune & Stratton New York*

8 Hahn, P F, Bale, W F, Ross, J. F., Balfour, W M. & Whipple, G H *(1943) J exp Med*, 78, 169

9 Hegsted, D M, Finch, C A & Kinney, T D *(1949) J exp Med* 90, 147

10 Sheldon, J H *(1935) Haemochromatosis Oxford Univ Press, London*

11 Taylor, J, Stiven, D & Reid, E W *(1931) J Path Bact* 34, 793

12 Taylor, J, Stiven, D. & Reid, E W. *(1935) J Path Bact* 41, 397

13 Walker, A R P & Arvidsson, U B *(1950) Nature Lond*, 166, 438

14 Waterlow, J C *(1948) Spec Rep Ser med Res Coun, Lond No 263*

Table 2

The disease pattern of 255 healthy villagers and 200 healthy children, aged 9 to 19 years

Condition	Percentage incidence among	
	255 healthy villagers	200 healthy schoolchildren
Ancylostomiasis	52	8 5
Ascariasis	76	42
Anaemia	95	87.5
Liver enlargement	33	18 5
Malarial parasitaemia	32	41
Schistosomiasis	9	-
Signs of malnutrition	26	25
Splenic enlargement	46	22
Streptocerciasis	21	-
Yaws	75	1 5

The signs of malnutrition most commonly found were cheilosis, angular stomatitis and mosaic skin on the lower limbs. A person was considered to be anaemic if the haemoglobin value of the blood was lower than the accepted lowest normal value for the age group in question in Britain[2] It should also be stated that in certain areas of the Gold Coast 10 per cent of the population may be blind from the ravages of onchocerciasis, and the incidence of schistosomiasis in children may be as high as 80 per cent

From table 1, it will be seen that iron was commonly found in the liver of new-born infants in the Southern Gold Coast. It decreased in incidence until adult life, when it increased with advancing years In children and females of child-bearing age the incidence of histochemically demonstrable iron in the liver cells was less than the incidence in adult males. This is surprising as children and women of child-bearing age were the groups of the population in which the signs of malnutrition were greatest and in which one would have expected the greatest incidence of haemosiderosis to occur if malnutrition was the aetiological agent in its causation. On the other hand, these are also the groups which exhibited the greatest degree of anaemia and which utilized the greatest amount of iron so it is possible that these factors, plus the added loss of iron due to parasitic infestation may have prevented the accumulation of iron in the organs and the occurrence of haemosiderosis

It has been shown, however, that anaemic dogs absorb much more iron than normal dogs[8]. It has also been shown that the Gold Coast African is anaemic (table 2) Thus, from an early age the African is probably absorbing large amounts of iron to combat the anaemia constantly present Haemosiderosis is prevented by the increased utilization of iron by those in the younger age groups and also by the greater loss of iron caused by parasitic infestations It is possible that the 'mucosal block' of the intestinal mucosa may become

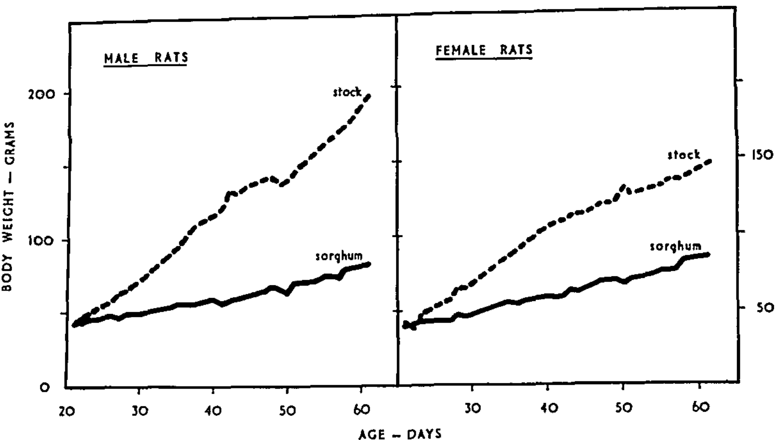


Fig 1 Typical individual growth curves for litter mates fed on the stock and sorghum diets

GROWTH, NITROGEN BALANCE AND HISTOLOGICAL PICTURE OF ORGANS OF RATS FED ON GAMBIAN DIETS

by

Brigid M Balfour

Experiments were designed to investigate the effect of feeding rats on diets as nearly as possible the same as those eaten by the Africans in the Gambia The quantities of foodstuffs used were based on a nutrition survey carried out at Yoro Beri Kunde* but, of course, represented a very much simplified version of the actual diet eaten. During the period May to September, sorghum was found to be the principal cereal eaten, and in planning the rat diet it was decided to neglect the occasional rice, pennisetum or maize meal eaten and use sorghum alone. The other constituents of the diet recorded in the survey included groundnuts, a variety of fresh and dried leaves, and small amounts of milk and occasional meat meals. The rats were fed on a simplified form of this diet which consisted of a meal made from the grain (sorghum or pennisetum) 100 parts, to 5.5 parts groundnuts, 1 0 part dried baobab leaf and 1.0 part sodium chloride In addition, each rat received 2 i.u. of vitamin D three times a week.

The sorghum flour was prepared from whole grain as far as possible in the African manner. The grain was washed and left to swell for 15 minutes, pounded in a mortar for about one hour and washed again, and the excess water was drained off. The grain was then covered with blotting paper and put to germinate overnight in an incubator at 37°C It was found that about 50 per cent of the grain germinated under these conditions. The next morning the grain was ground in a mill, sieved to remove bran and dried at room temperature for 24 hours This process gave an extraction of about 80 per cent of the grain. Finally the groundnuts, baobab leaf and salt were added to the dried sorghum flour with water in the proportion of 30 per cent solids to 70 per cent water and the mixture was cooked in a double saucepan for half an hour

This diet was fed *ad libitum* to weanling rats, and the laboratory stock diet was fed to litter mate controls The majority of the animals were left on the diet for 40 days.

The growth of the animals on the sorghum diet was very much retarded. The average daily increase in weight of the stock animals for the period 21 to 62 days of life was 3 9g for males and 2.95g for females, and of the sorghum-fed animals, 1 08g for males and 1 10g for females. Typical individual growth curves for litter mates on the two diets are shown in figure 1. In a few experiments the rats were kept on the diets for longer periods The 'sorghum rats' continued to increase at a steady rate and it is possible that they would eventually have grown to the full size though small, they were active and appeared to be in fairly good health They

* see p 261 reference 2

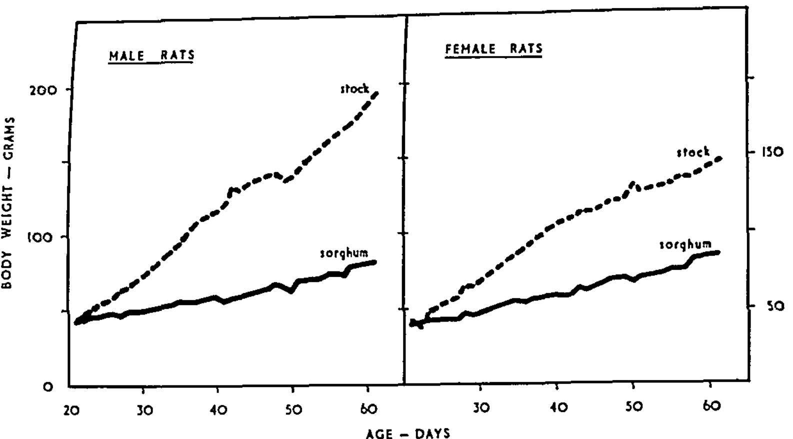


Fig 1 Typical individual growth curves for litter mates fed on the stock and sorghum diets

were thin, with very prominent eyes and lax skins, and their muscle power was reduced. In the control rats the fine short hair of the baby rat was replaced by the long hair of the adult type between the 45th and 55th day of life, but in the animals fed on sorghum, the fine hair persisted and bald patches began to appear between the 40th and 50th day of life on the heads and flanks of a number, and in nearly all animals the whiskers were broken off short. There was also a distinct greying of the black hood in the hooded animals The rats appeared to spend much time pulling out each other's hair and in some cases eating it. Apart from slight scaliness of the feet, no other gross abnormalities were observed.

Various supplements were added to the basic sorghum diet and the body weights of the animals were recorded There was an immediate response when 13.5 per cent casein was added The average daily increase in weight of the animals rose to 5 4g for males and 5 0g for females With a supplement of 13 5 per cent gelatin, the daily weight gains were 4.3g for males and 4 1g for females, and with a supplement of 0.85 per cent lysine the daily weight gains were 3.2g for males and 2 5g for females. No change in the rate of weight gain occurred when supplements of cystine, methionine, the vitamin B-complex plus inositol and choline or the fat-soluble vitamins were added.

Figures for the composition of sorghum flour are very incomplete and may vary with different samples. A few analyses of the samples used in this experiment were carried out. The nitrogen was 2.22g, fat 3.67g and fibre 1.48g, each per 100g dry weight. Assuming that all the nitrogen was present as protein, the concentration would have been 13.9 per cent, which is not considered adequate for a growing rat, whatever it may be for a human being The nitrogen content of the stock diet was 3 7g per 100g dry weight, equivalent to a concentration of 23 per cent protein which is adequate for a growing rat

No recent analysis of the amino-acid composition of sorghum could be found in the literature, but older work[2,4] indicates that the lysine content is low. Hogan[3] fed rats on a sorghum diet and obtained a growth response when a supplement of lysine was added. However, further work is necessary before the role of lysine can be established.

In addition to the experiments on young animals, it was decided to breed from animals reared on the sorghum diet from weaning. The females fed on sorghum became pregnant slightly later than their litter-mate controls on stock diet and produced litters which appeared to be mature but whose birth weights were slightly lower than the controls The 'sorghum females' immediately began to eat their litters and did not make nests or show any maternal solicitude for their young This behaviour is usually observed in animals who fail to lactate and the hope of rearing animals suckled by mothers on the Gambian diet had to be abandoned.

The second cereal used in the experiment was pennisetum, or bulrush millet. The flour was prepared in the Gambia by Africans, then dried and sent back to England. In the rat diet, pennisetum flour was substituted for the sorghum flour of the first diet and was cooked with the same amount of water, groundnuts, baobab leaf and salt. It was fed as before, *ad libitum* to weanling rats with litter-mate controls on the stock diet. The growth of animals on the pennisetum diet was also retarded. The average daily increase in weight of the stock animals for the period 21 to 62 days of life was 3.6g for males and 2.6g for females, and of the 'pennisetum animals', 1.0g for males and 0.75g for females. The appearance of the animals was very like that of the animals on the sorghum diet, although the lax skin and muscular weakness were rather more marked in some cases. Similar hair changes occurred at about the same time. With a supplement of 13.5 per cent casein the average daily weight gain was 3.5g for males, and with a supplement of 0.65 per cent lysine, 2.67g. No further improvement in weight gain was observed when supplements of each of the other essential amino-acids were given with the lysine supplement, nor was there any weight response to supplements of the vitamin B-complex plus inositol and choline or the fat-soluble vitamins. Typical individual growth curves for these litter mates, fed the stock diet, pennisetum diet, and pennisetum diet plus casein are shown in figure 2. The average nitrogen content of the pennisetum diet was 1.7mg per 100g dry weight, equivalent to a protein concentration of 10.6 per cent, which is slightly lower than the figure for sorghum.

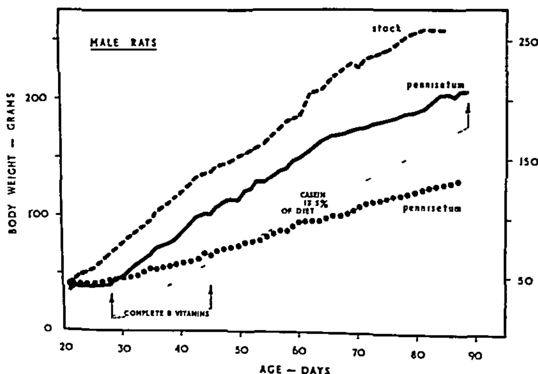


Fig 2 Typical individual growth curves for litter mates fed on (a) the stock diet (b) the pennisetum diet (with the vitamin B-complex added for 18 days) (c) the pennisetum diet supplemented with casein

(11826)

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kidney weights of a number of animals, the majority of which were killed at 62 days life, were recorded, also the organ weights of younger control animals. The liver weights of the sorghum and pennisetum animals and of control animals of various ages were plotted against their body weights, and fell nearly on a straight line (figure 3). There was certainly no liver enlargement in the sorghum and pennisetum animals. In fact, in a few cases their liver weights fell below the mean The kidney weights followed very much the same pattern.

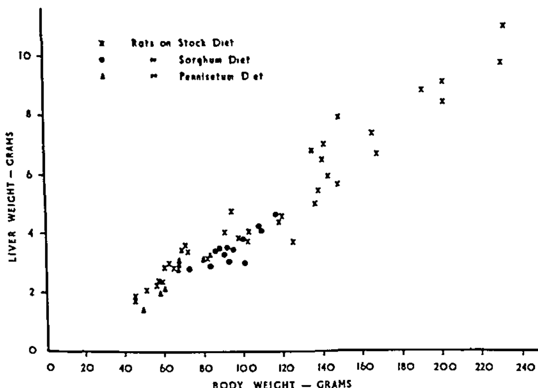


Fig 3 Relationship between body weight and liver weight in 57 rats fed on various diets

As the livers of these animals were underweight, it seemed of interest to find out if the cells were correspondingly small, or if their number was also reduced A rough estimate of liver cell weight was obtained by nuclear counts on homogenates of these livers Figure 4 shows that the count rose as the liver weight fell. This relationship held for control animals of different ages and for control, sorghum- and pennisetum-fed animals of the same age In normal animals the liver cells apparently increased in weight very rapidly until the liver weighed about 4 to 5g, after which there was a slower increase. The counts for the 'sorghum' and 'pennisetum animals' were slightly higher than the counts for younger control animals having the same liver weight but were of the same order.

Nitrogen balances were carried out on some of the animals on the pennisetum diet and on control animals on the stock diet. The figures for total nitrogen intake, output, percentage retention and absorption are given in table 1. The nitrogen intakes of the 'pennisetum animals' were very much lower than the intakes of the animals on the stock diet, but the percentage retention of nitrogen was of the same order, indicating an efficient use of the available nitrogen. The percentage absorption was also of the same order. The results of balances on animals receiving the pennisetum diet plus a supplement of 0.85 per cent lysine showed a slightly better utilization of ingested nitrogen.

Table I

Nitrogen balances (per head per day)

Diet	Intake (mg)	Output (mg)	Percentage retention	Percentage absorption	Average daily weight gain (g)
Stock	341 6	207 9	38 1	84 7	2 6
"	313 3	218 5	30 2	83 4	2 33
"	444 0	282 2	36 3	86 4	2 64
Pennisetum	187 4	111 5	40 5	77 3	2 0
"	237 3	153 7	35 23	79 89	2 0
"	209 1	136 7	34 6	81 2	1 7
" + 0 85% lysine	188 5	100 4	46 5	76 4	3 6

An attempt was made to discover if any of the supplements added to the pennisetum diet influenced hair growth and colour, but the results were rather confusing. With a supplement of 13 5 per cent casein the quality of the hair appeared to improve, it began to change from the fine short hair of the young rat to the adult type, but greying and baldness appeared earlier than usual It was thought that the baldness might be due to a sulphur amino-acid deficiency, but a supplement of 13.5 per cent casein plus 0 4 per cent cystine did not prevent it No improvement was observed when supplements of the vitamin B-complex or inositol were added to the basic diet.

Finally, 13.5 per cent skimmed milk powder was substituted for casein in the rations of animals who had developed baldness and greying of the black hood. Within five days, thick black hair began to appear in the bald areas, interspersed with the remaining long grey hairs

The post-mortem findings in the animals fed on sorghum and pennisetum were very unimpressive. The lax papery skins and the absence of fat were striking, but, apart from slight mottling of the liver, the internal organs appeared to be normal The liver and

Table 2b

Comparison of the number of liver cells in animals killed at age 61 to 69 days on the control diet and on a Gambian diet

	Control diet	Gambian diet
No of animals	14	18
Mean total no. of cells (millions)	1607	1187
Standard deviation	295	161

$t = 5.2$

Microscopic examination showed no gross alteration of the liver structure Necrosis, cellular infiltration, fibrosis or severe fatty infiltration did not occur. A small amount of fat, mostly in small globules, was present, more in the livers of animals fed on sorghum than in those fed on pennisetum. It was reduced, though not entirely absent, in animals receiving a supplement of the vitamin B-complex plus inositol and choline The other change constantly found was a replacement of the cytoplasm of the cells in the periphery of the lobule by an amorphous substance which appeared to consist largely of glycogen Small fat globules were found embedded in this substance. This appearance has been described in animals fed on non-protein and low protein diets[5]. The glycogen may rise from 2 to 4 per cent to 9 per cent, with a corresponding fall in nitrogen content this change was largely reversed by feeding a supplement of 0.65 per cent lysine with the sorghum diet. Fourteen days after the supplement had been added, the appearance of the liver cells was strikingly different, though not normal. The cells contained less than the normal amount of glycogen, and the dense cytoplasm was packed with small mitochondria, an appearance seen in regenerating tissue. A supplement of the vitamin B-complex plus inositol and choline also reduced the glycogen content of the liver, though it was still present in an abnormally large amount in some cells It has been shown that in protein depletion complicated by choline deficiency the glycogen content of the liver rises as well as the fat content[6]

The changes observed in the liver cell nuclei in the 'sorghum' and 'pennisetum animals' responded in very much the same way as the cytoplasmic changes The small, dense nuclei containing often a single, very large nucleolus, found in animals on the Gambian diets were not observed in animals given a supplement of lysine or gelatin With a supplement of the vitamin B-complex plus choline, the minute structure of the nuclei was more nearly normal but the nuclei were still very small The changes in the pancreas in animals on the sorghum diet were not very dramatic and cannot be compared with those reported by Professor Davies[1] but the size of the cells and the number of secretory granules present were greatly reduced. Small globules of fat were found, in some cases occupying a considerable

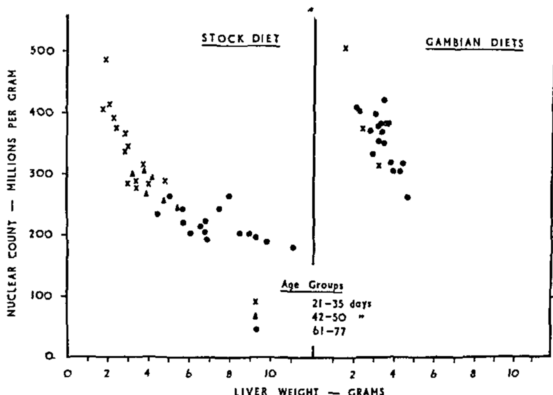


Fig 4 Relationship of liver weight to nuclear count in 57 rats fed on various diets

Figures for the total number of cells in the livers were obtained by multiplying the counts per gram by the total liver weights These figures show a considerable scatter but there has been significant increase in the total number of cells over the period 21 to 62 days of life in normal animals The figures for the 'sorghum' and 'pennisetum animals' killed at 62 days of life were significantly lower than their stock controls, and it seems that the rate of mitosis was reduced as well as the growth of individual cells (table 2)

Table 2a

Comparison of the number of liver cells in animals on the control diet killed at age 21 to 28 days and at age 61 to 63 days

	21-28 days	61-63 days
No of animals	12	14
Mean total no. of cells (millions)	917	1607
Standard deviation	108	2[illegible]5

t = 7 3

EXPERIMENTS ON DIETARY LIVER INJURY

by

O. Lindan

1. EFFECT OF GROWTH AND PREGNANCY ON DEVELOPMENT OF FATTY INFILTRATION OF THE LIVER

Pregnancy and childhood are periods of life when the stress of growth is operative. Growth with its raised metabolic rate and great need for building materials may increase the demand for certain foodstuffs, such as lipotropic factors, and diets which would be adequate for an adult non-growing organism may not prevent symptoms of nutritional deficiencies when given to the young or to those who are pregnant. In the present investigation the effect of growth and pregnancy on the precipitation of fatty infiltration of the liver was examined in rats deficient in lipotropic factors[19]

A high fat content of the liver should be regarded as a significant lesion. Although fatty infiltration is now generally accepted as one of the precursors of the grave liver condition known as portal cirrhosis[10,12,13], it has only recently been recognized as a serious liver injury *per se*, which results in impaired hepatic function This has been demonstrated by the failure of fatty livers to inactivate oestrogens[9] and by the appearance of an anti-diuretic factor in the urine of animals with high liver fat content[17]. Fatty infiltration, therefore, produces injuries to liver function qualitatively similar to those produced by cirrhosis.

Fatty livers can be produced by diets completely deficient in choline and partially deficient in protein[3,4]. Examination of the protein constituents has revealed that methionine possesses lipotropic activity and that cystine has an opposite effect and precipitates fatty infiltration [1,5,7,26]. The lipotropic action of methionine has been shown to be due to its ability to provide methyl groups for the formation of choline from ethanolamine[8]. The effect of cystine in precipitating fatty infiltration has been attributed to its power of promoting growth and increasing metabolic rate[11], thus indirectly increasing the requirements for choline and methionine[15,25]

Effect of growth rate of young rats on the development of fatty infiltration

In experiments on young animals, two lipogenic diets were used. Their composition is given in *table 1*. Both diets were given in amounts ensuring identical daily consumption of all constituents except carbohydrates The amounts of fat, salts and vitamins

part of the cytoplasm, and the fine, thread-like mitochondria observed in the control animals were reduced in number and those remaining were very swollen. In the animals on the pennisetum diet, the pancreatic cells, though small, contained a number of secretory granules, the fat was very much less and the mitochondria were more nearly normal in appearance.

The evidence suggests that the liver changes are quickly reversible and do not lead to any early structural changes

The effects of feeding animals on these diets for long periods have not yet been investigated.

Plates 32 to 35 are microphotographs of sections of rat livers They illustrate the effects of feeding (a) the sorghum diet alone, and (b) this diet supplemented with lysine and with the B-complex of vitamins plus choline and inositol

REFERENCES

1 Davies, J N P *This Report p 109*

2 Dowell, C T & Menaul, P. *(1921) J biol Chem*, 46, *437*

3 Hogan, A G *(1918) J biol Chem*, 33, *151*

4 Jones, D B & Johns, C O *(1918) J biol Chem* 36, *329*

5 Kosterlitz, H W *(1947) J Physiol* 106, *194*

6 Wang, C-F, Hegsted, D M, Lapi, A, Zamcheck, N & Black, M B *(1949) J Lab clin Med*, 34, *953*

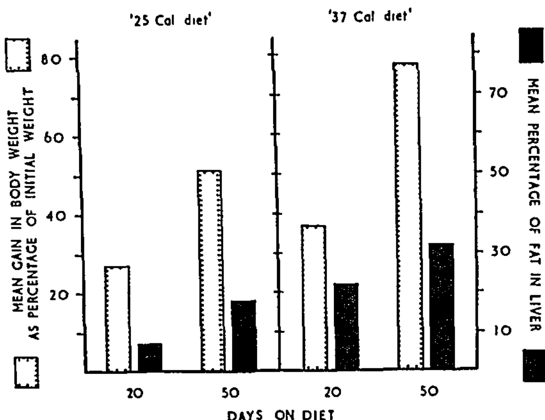


Fig 1 Effect of calorie intake on growth and liver fat content of young rats mean initial body weight 68 g

precipitate liver fatty infiltration The effect of varying carbohydrate intake at different growth rates was eliminated by supplying 25 Calories per rat per day to three groups of animals of different initial body weight and therefore of different ages. Figure 2 shows that the degree of fatty infiltration was roughly proportional to the growth rate, the fastest growing animals showing the highest liver fat content while the animals growing slowly showed almost normal fat levels.

Although different degrees of fatty infiltration, related to different growth rates, were produced on the same carbohydrate intake, a second question arises how far did the calorie rationing result in an excess calorie intake by small rats and a deficient intake by the larger rats? The answer is obtained from an analysis of growth of the three groups of rats of different ages given 25 Calories daily (see figur 2) Their mean initial body weights were 50, 63 and 80g, and after 20 days on the experimental diet they had all attained about the same weight (83,80 and 82g respectively) Although at this stage their body weights and food intakes were

(11926)

supplied were considered to be adequate for norral development of the rat. The amount of casein was lower than the accepted optimal protein requirement. The two levels of carbohydrate intake provided two different calorie intakes of 25 and 37 Calories per rat per day.

Table I

Composition of diets for experiments on growth rate of young rats and development of liver fatty infiltration

Diet	Calories/rat/day	mg/rat/day					
		Sugar - corn starch (1 19)	Casein	L-cystine	Salt mixture (Glaxo L D 6)	Arachis oil	Cod liver oil
'25 Cal'	25	4 400	640	50	240	450	65
'37 Cal'	37	7,100	640	50	240	450	85

The diets were supplemented with the following vitamins per rat per day

Thiamine HCl 25 µg, riboflavin 20 µg, pyridoxine 25 µg, calcium pantothenate 100 µg, dl- α - tocopherol acetate 1 5 mg

The effect of calorie intake on growth and liver fat content of young rats is shown in figure 1. The increase of calorie intake from 25 to 37 Calories per rat per day increased the gain in body weight from 27 to 37 per cent (g gain/100g initial body weight) after 20 days of experiment, and from 51 to 77 per cent after 50 days The liver fat content was similarly raised from 7 to 22 per cent (g fatty acids + unsaponifiable lipids*/100g liver after 20 days and from 18 to 32 per cent after 50 days

It could be asked whether the increased liver fat content was the result of the higher growth rate *per se* (increased anabolism) or was due specifically to the higher carbohydrate intake The latter is probable in view of the work of Best and his co-workers who showed that increased carbohydrate intake alone can

* Method of Kumagawa and Suto described by Leathes and Raper[16]

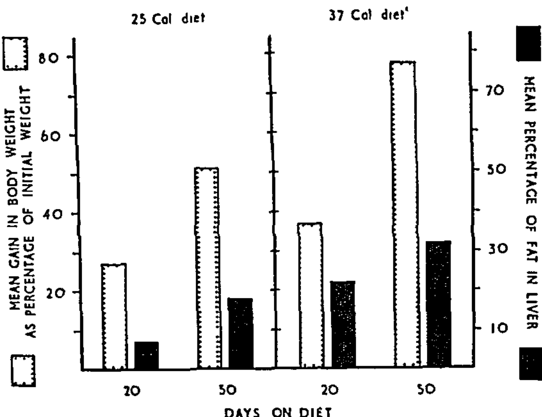


Fig I Effect of calorie intake on growth and liver fat content of young rats mean initial body weight, 68 g

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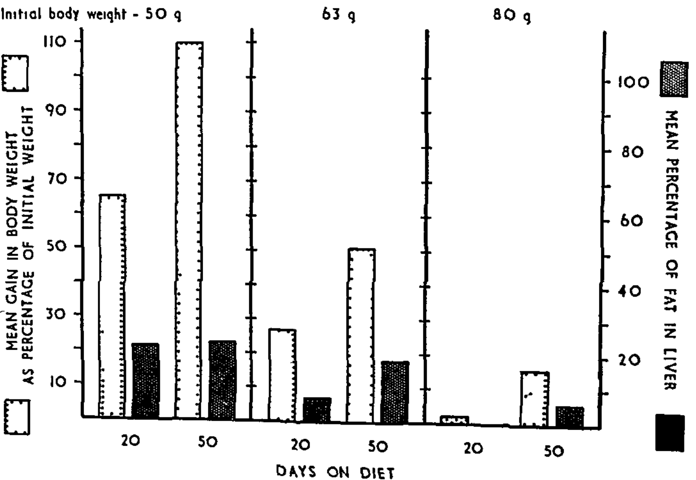


Fig 2 Effect of growth on liver fat content of young rats fed '25 Cal ' diet

identical, the three groups continued to grow at different rates, the gain in weight during the next 30 days being 22, 18 and 11g respectively. In this 30 day period the problem of the relation between body weight (or body surface area) and food intake (building materials and energy supply) has been eliminated. The animals which were lightest initially (50g) had already attained maximum liver fatty infiltration after the first 20 days, but the other two initially heavier groups (63 and 80g) showed rises in the liver fat content proportional to the growth rates during the second half of the experimental period (30 to 50 days).

Two conclusions may therefore be drawn (a) that giving identical amounts of the lipogenic diet to rats of different initial body weight (and therefore age) reveals that the younger the animals, the better their utilization of food for growth, and the greater their susceptibility to liver fatty infiltration, (b) that an abundant supply of carbohydrates to young growing animals is a predisposing factor to the development of liver fatty infiltration

Pregnancy as a precipitating factor in fatty infiltration of the liver

In the experiments on the effect of pregnancy on liver fatty infiltration, three diets low in lipotropic factors were used, their composition is shown in table 2. There was 16 per cent casein in the first diet it contained a moderate amount of methionine and was therefore only slightly deficient in lipotropic factors. The second and third diets contained only 8 per cent casein and were accordingly deficient in methionine The lipogenic effect of the third diet was increased by the addition of cystine The food was given *ad libitum*

Table 2

Composition of diets for experiments on the effect of pregnancy on liver fatty infiltration

Diet	g/100g diet					
	Casein	L-cystine	Salt mixture (Glaxo L D 6)	Arachis oil	Cod liver oil	Sugar - corn starch (1 19)
'16% casein'	16 00	-	3 00	5 00	1 00	75 00
' 8% casein'	8 00	-	3 00	5 00	1 00	83 00
' 8% casein + cystine'*	8 00	0 63	3 00	5 00	1 00	82 37

Supplements of water-soluble vitamins and dl-α-tocopherol acetate were given daily as in table 1.

*8 5g of '8% casein + cystine' diet corresponded to '37 Cal ' diet (table 1) in the previous experiments on the effect of growth on liver fatty infiltration in young animals

The effect of pregnancy on development of liver fatty infiltration is shown in figure 3. Adult, non-pregnant rats given the three experimental diets for 26 or 52 days had normal liver fat content, that is between 4 and 5 per cent. The effect of pregnancy in increasing the fat content of the liver varied with the degree of dietary deficiency and the animal's nutritional status before gestation. Thus, in pregnant rats given the 16 and 8 per cent casein diets only during mating and pregnancy (altogether 26 days) the liver fat content increased to 8 and 9 per cent respectively, but in those mated after a preparatory period of 26 days on these diets (total 52 days on deficient diet) the liver fat content at the end of pregnancy rose to 12 and 14 per cent. When the '8 per cent casein + cystine' diet was used, fatty infiltration was most marked and the fat content amounted to 29 and 22 per cent after 26 and 52 days respectively.

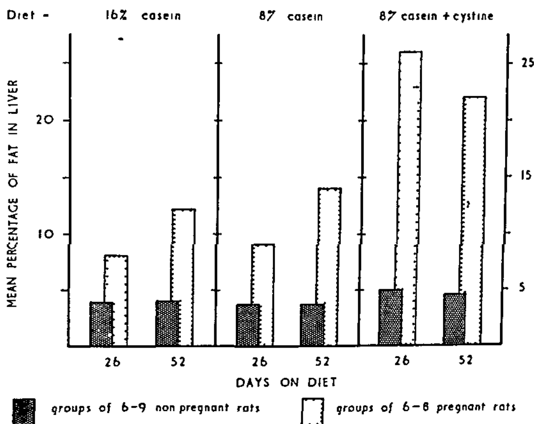


Fig 3 Effect of pregnancy on fatty infiltration of the liver

Histological examination of foetal livers showed the absence of fatty infiltration, although the lesion was present in maternal livers

The mean gain in body weight of non-pregnant rats during 20 days on an experimental diet (with or without preparatory depletion) represented an increase of 11 per cent of the initial body weight, the pregnant rats gained during the same period on an average, 41 per cent The cause of the dietary injury produced by pregnancy may be ascribed therefore to the increase in tissue growth during gestation

The conclusions drawn from this experiment are (a) that pregnancy may precipitate fatty infiltration of the liver in rats given a diet which does not produce the liver lesion in non-pregnant adults, (b) that the administration of deficient diets during a period before mating, although not producing any visible harm, leads to a greater degree of fatty infiltration during subsequent pregnancy (c) that the degree of fatty infiltration precipitated by pregnancy depends on the extent of dietary deficiency, (d) that although maternal livers are heavily affected by choline deficiency, the foetal livers remain normal

Discussion

It should be borne in mind that the diets were artificial and specially purified in these experiments to produce fatty infiltration in young or pregnant rats without dietetic liver necrosis[14,18 19 20] In natural diets the dietary factors responsible for the prevention of these two lesions usually occur together, and consequently liver lesions from dietetic deficiencies tend to be multiple Lipotropic factors were thus shown experimentally to be required for growth and also to be essential for maintaining normal liver function The occurrence of liver damage during growth indicates that maintenance of liver function is subservient to growth This means that methionine in the young or the pregnant will be used for building new tissues rather than for normal liver metabolism. The depleting effect of growth is roughly similar in pregnant adults and in young animals, as judged by the degree of liver fatty infiltration produced by analagous alipotropic diets

The experiments on adult animals show that the course of pregnancy may be affected by the animal's nutritional state before the onset The animal may appear to be normal but have subclinical deficiency of lipotropic factors, and during the additional metabolic stress of the pregnancy may succumb rapidly

Fatty infiltration of infantile liver is already a well recognized condition in some parts of Africa[6] and it occurs predominantly after weaning onto a staple diet rich in carbohydrates and

obviously deficient in some lipotropic factors. It follows, therefore, that the same alipotropic diet is not so harmful to adults as to infants. It is interesting to note that fatty livers are not common in Gambian weanlings and, as Platt [21] points out (page 97) the Gambia is one of the few places in Africa where the habit of forcible feeding of infants with an excess of carbohydrates is uncommon. This agrees well with the experimental evidence of the effect of an abundant supply of carbohydrates on liver fatty infiltration in the young.

In pregnant women minor degrees of liver fatty infiltration are common It is, however, not generally recognized that in pregnant women, heavy fatty infiltration may occur comparable to that produced experimentally in rats[22,24,27], the women were reported to have had the clinical signs of 'acute yellow atrophy', but at autopsy the liver showed gross fatty infiltration. In the present experiments the occurrence of normal liver in foetuses from mothers with fatty livers is in conformity with the well known 'parasitic effect' of the growing foetus. If the recent reports [23] that heavy fatty infiltration can be found in new-born African children are confirmed, and if this fatty infiltration is found to be due to dietary deficiency, then the question arises as to the extent of liver damage in the mother

Summary

Growth and pregnancy precipitated the development of heavy fatty infiltration of the liver in rats given a diet which, although alipotropic to some degree, did not in the absence of these stresses produce deficiency symptoms. The relevance of the experimental results to similar liver lesions in human subjects is discussed

2 SIZE AND COMPOSITION OF FATTY LIVERS IN RELATION TO DIETARY PROTEIN AND CARBOHYDRATE

It is apparent from the evidence presented in this Report that malnourished African children may show varying degrees of liver fatty infiltration, the presence or absence of hepatomegaly and variable amounts of subcutaneous fat These clinical pictures are constantly associated with protein deficient diets The variations in the clinical picture seen in different parts of Africa may be due to the varying degrees of protein deficiency and to the effect of varying calorie intake in the form of carbohydrates or fat

The experiments presented here were made in order to investigate the modifying effect of varying imbalance of protein and carbohydrate on the composition of fatty liver in the early stages, before fibrosis began to develop. It was known from previous experimental work[10] that as fibrosis develops in a fatty liver the fat content diminishes

(a) Fatty infiltration of the liver in the growing rat

Two groups of female rats, with mean body weights of 72 and 77g were given a lipogenic diet containing a suboptimal amount of protein but adequate carbohydrate ('37 Cal. diet', table 1) Group A received this diet supplemented with choline (table 3), group B received no supplement. The animals in both groups continued to grow and maintained a good layer of subcutaneous fat throughout the experiment

After 50 days on the experimental diets all the rats were killed and their livers examined. The fat content of the livers of those rats receiving the choline supplement was only 6 per cent, which is nearly normal, while the livers of their sister rats fed the unsupplemented diet contained 32 per cent of fat. This increase in fat was paralleled by a decrease in the percentage of water and protein. The former fell from 69 to 48 per cent and the protein from 19 to 12 per cent.

The fatty livers of group B were heavier than those of group A. The amounts of water and protein were the same in normal and fatty livers, the increase in liver weight of the animals of group B being due almost entirely to the increase in fat (figure 4)

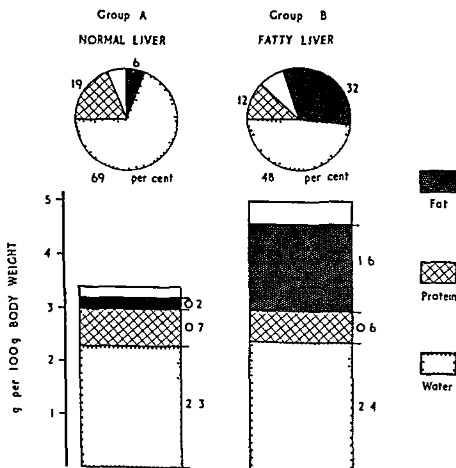


Fig 4 Composition of normal and fatty liver in a growing rat

Table 3

Liver composition and size in relation to fatty infiltrations of dietary origin

Group of four rats	Diet (see table 1)	Choline supplement 10 mg per rat per day	Mean body weight (g)		Mean liver wt. g/100g body wt.	Mean liver composition					
						Fat		Protein		Water	
						g per 100g of					
			Initial	Final		liver	body wt.	liver	body wt	liver	body wt.
A	'37 Cal.'	+	77	125	3.4	6	0.2	19	0.7	69	2.3
B	'37 Cal.'		72	124	5.1	32	1.6	12	0 6	48	2 4
C	'25 Cal.'		138	123	2 7	9	0.2	19	0.5	65	1 8

It should be pointed out that this superimposition of fat on the normal gross liver constituents occurs only in the initial stages of fatty infiltration. There is some evidence that when heavy fatty infiltration has been present in the liver for some time, there is a retention of water and protein, so that the non-fatty portion of the liver is increased out of proportion to the body weight and, further, altered in composition[14]

(b) Fatty infiltration of the liver in the starving rat

The picture of fatty livers produced by a lipogenic diet in the non-growing, starved animal was different (group C, table 3). When the '25 Cal diet' (table 1) was given to rats weighing 138g they lost weight and their subcutaneous fat decreased For animals of this size the diet was deficient not only in protein but also in carbohydrates. After 50 days their body weight had fallen to 123g and matched the final body weight of the rats in groups A and B (125 and 124g respectively). The livers were considerably smaller than normal and the percentage of fat present was only moderately increased to 9 per cent. Table 3 shows that the percentage of the two other main liver constituents and the total amounts of fat, protein and water in the whole liver were quite different from the composition of fatty livers from non-starving animals. It should be pointed out that in a starved animal there are two other factors present, namely, the flooding of the liver by fat mobilized from the periphery, and depletion of the protein reserves of the liver.

These two distinct types of fatty infiltration due to malnutrition produced experimentally may be related to the size and fat content of the liver and to the variations in subcutaneous fat in malnourished African children before the development of post fatty fibrosis

Summary

Rats were shown to develop two types of fatty livers depending on the supply of protein and carbohydrate in the lipogenic diet

A diet which contained suboptimal amounts of protein and adequate carbohydrate allowed the animal to grow and produced an enlarged fatty liver. This enlargement was due to an excess of fat, the protein and water content of the whole liver being normal.

On the other hand, a lipogenic diet which was deficient in protein and also in carbohydrates resulted in a loss of weight of the animal and a fatty liver of reduced size. This reduction in size was shown to be due to a loss of liver protein and water.

It is suggested that there may be a relationship between these experimental findings and similar observations in malnourished African children

Table 3

Liver composition and size in relation to fatty infiltrations of dietary origin

Group of four rats	Diet (see table 1)	Choline supplement 10 mg per rat per day	Mean body weight (g)		Mean liver wt. g/100g body wt.	Mean liver composition					
						Fat		Protein		Water	
						g per 100g of					
			Initial	Final		liver	body wt.	liver	body wt.	liver	body wt.
A	'37 Cal '	+	77	125	3.4	6	0 2	19	0.7	69	2.3
B	'37 Cal.'		72	124	5.1	32	1.6	12	0 6	48	2.4
C	'25 Cal '		138	123	2 7	9	0 2	19	0 5	65	1 8

20 Lindan, O & Himsworth, H. P (1950) *Brit J exp Path*, 31, 651

21 Platt, B S (1951) *Personal communication*

22 Sheehan, H L (1940) *J Obstet Gynaec, Brit Emp*, 47, 49

23 Silvera, W D & Jelliffe, D B (1952) *J trop Med (Hyg)*, 55, 73

24 Stander, H J & Cadden, J. F (1934) *Amer J Obstet Gynec*, 28, 61

25 Treadwell, C R., Tidwell, H. C. & Gast, J. H (1944) *J biol Chem*, 156, 237

26 Tucker, H. F & Eckstein, H C (1937) *J biol Chem.*, 121, 479

27 Whitacre F E & Fang, L Y (1942) *J Amer med Ass*, 118, 1358

My thanks are due to Sir Harold Himsworth, F R.C.P., for his valuable advice and encouragement in this work.

REFERENCES

1 Beeston, A W , Channon, H J , Loach, J V & Wilkinson, H (1936) *Biochem J* , 30, 1040

2 Best, C H , Hartroft, W S , Lucas, C C & Ridout, J H (1949) *Brit med J* , ii, 1001

3 Best, C H & Huntsman, M E (1935) *J Physiol* , 83, 255

4 Best, C. H , Mawson, M E H , McHenry, E W. & Ridout, J H (1936) *J Physiol* 86, 315

5 Best, C H & Ridout, J. H. (1940) *J Physiol* , 97, 489

6 Brock, J F & Autret, M (1952) *Bull World Hlth Org* , 5, 1

7 Channon, H J , Manifold, M C & Platt, A P (1938) *Biochem J* 32, 969

8 du Vigneaud, V , Cohn, M , Chandler, J P , Schenck, J R & Simmonds, S (1941) *J biol Chem* , 140, 625

9 Ferret, P (1950) *Brit J exp Path* 31, 590

10 Glynn, L E , Himsworth, H P & Lindan, O (1948) *Brit J exp Path* 29, 1

11 Griffith, W H (1941) *J Nutr* , 21, 291

12 Himsworth, H P (1950) *The Liver and its Diseases*, 2nd ed Blackwell Oxford

13 Himsworth, H P & Glynn, L E (1944) *Clin Sci* 5, 133

14 Himsworth, H P & Lindan, O (Unpublished)

15 Horning, M G & Eckstein, H C (1944) *J biol Chem.* 155, 49

16 Leathes, J B & Raper, H S (1925) *The Fats* Longmans Green & Co , London

17 Leslie, S H & Ralli, E P (1947) *Endocrinology* 41, 1

18 Lindan, O (1951) *Brit J exp Path* 32, 471

19 Lindan, O (1951) *The Effect of Growth in Precipitating Nutritional Injury*, Ph D Thesis, University of London

FATTY LIVER IN NEW-BORN AFRICAN INFANTS

by

H D Silvera

The majority of investigators in areas where malnutrition is rampant have concentrated on the clinical and pathological studies of the child after weaning Very little attention has been paid to the pathology of the intra-uterine and the breast feeding periods In a series of liver biopsies on Nigerian children, Silvera and Jelliffe[1] examined material from 28 children Of these, 13 were under one year old and 15 over one year old

The parents of all the children were living on low incomes The standard diet of the average Yoruba mother is grossly deficient in proteins and other essential nutrients All grades of malnutrition are common among children of these parents

Histologically extensive fatty change is found not only in clinically severe malnutrition of the after-weaning period but also in stillborn foetuses and in babies in the first month of life Cases 12 and 13 were apparently healthy infants save for ophthalmia and thrush respectively (plates 40 41) It is considered unlikely that such fatty change could be caused by the trivial presenting complaints Also striking, but probably of less significance, is similar extensive fatty change in stillborn infants and those dying shortly after birth (Cases 4 and 5 - plates 42, 43)

The findings suggest that maternal malnutrition may have repercussions on the child during breast feeding and possibly also in the intra-uterine period Kwashiorkor may be present in latent form in some infants in apparent good health and while being breast fed Weaning in such infants would be regarded not as the cause, but only the precipitating factor of clinical kwashiorkor

REFERENCE

1 Silvera, H D & Jelliffe, D B. *(1952) J trop Med (Hyg)* 55, 73

FIBROSIS OF THE LIVER IN GAMBIAN CHILDREN

by J H Walters and J C Waterlow

Seventy-nine infants and children were investigated by liver biopsy This series was composed of four clinical groups

1 normal children as controls
2 children with symptomless hepatomegaly
3 malnourished infants
4 children with hepatomegaly, who were clinically ill, with oedema, ascites, or severe anaemia

Sections stained by Gomori's silver impregnation method showed three main types of change in structure and arrangement of the fibrous tissue

(a) A localized periportal fibrosis (plate 36) This lesion was extremely common, it was found in more than half the children of groups 1 and 2
(b) A fine periportal fibrosis (plate 37), which seemed to be spreading into the parenchyma This was most often found in infants
(c) Diffuse fibrosis, with destruction of the normal architecture (plate 38) Occasionally this was found in symptom-free subjects, but it was most common in the children of group 4

Severe diffuse fibrosis of the liver in childhood is illustrated in plate 39

The hypothesis was presented

(i) that the common, localized, periportal fibrosis is the result of malaria, which is universal in the early years of life
(ii) that fine periportal fibrosis and diffuse fibrosis represent successive stages of the same pathological process
(iii) that this process has a dual cause, and results from the combined stress of malaria and malnutrition

These results will be described in detail in a report to the Medical Research Council (now in preparation)

In considering the cause of enlarged livers in the tropics the importance of malaria is emphasized by the often very satisfactory clinical response to antimalarials of so-called 'deficiency livers' in children

2. **Pathogenic processes involved in liver change in malaria**

(a) **Pathogenesis** There is experimental evidence that constriction of the smaller branches of the hepatic venous tree can occur in some animals I believe that such constriction may be important in the genesis of centrilobular lesions, such as those seen in malaria[8] Constriction of the hepatic venous vessels following injection of antigen into the surface of the liver of a sensitized dog has been illustrated[9]

(b) **Anatomy and physiology of liver circulation** The portal tracts are surrounded by a network of large sinusoids, into which run branches from the portal vein and hepatic artery. Other sinusoids radiate from this network into the lobules The portal vein sends branches to the lobule via this periportal network It is also connected by short vessels to a plexus on the bile-ducts The hepatic artery supplies the tissues of the portal tract and sends branches to the periportal network There is some arterial anastomosis, especially on the surface of the liver Direct connections between the hepatic artery and the hepatic venous tree have been demonstrated anatomically and physiologically in the dog[1,2 3] Hepatic arterial blood probably mixes with portal venous blood immediately around the portal tract The bile-duct is surrounded by a rich plexus which receives branches from the portal vein and the hepatic artery Some vessels from this plexus appear to communicate direct with sinusoids Most sinusoids drain directly into small veins in the centre of lobules Sublobular veins may receive sinusoids direct but more usually after the latter have first gathered into short trunks

REFERENCES

1 Andrews, W H H & Maegraith, B G (1951) *Ann trop Med Parasit* 45, 255

2 Andrews, W H H & Maegraith, B G (1953) *Nature Lond* 171, 222

3 Andrews, W H H , Maegraith, B. G & Wenyon, C. E. M (1949) *Ann trop Med Parasit* 43, 229

4 Bruce-Chwatt, L J (1952) *Colonial Research 1951-2* H M S O Cmd 8665 p 121

5 Joyeux, C. & Sice, A (1950) *Precis de Medecine des Pays Chauds* Masson Paris

6 McGregor, I A & Smith, D A (1952) *Trans R Soc trop Med hyg* 46, 403

7 Maegraith, B. G (1948) *Pathological Processes in Malaria and Blackwater Fever* Blackwell Scientific Publications Oxford

8 Maegraith, B G , Andrews, W H H & Gall, D (1947) *Lancet* ii, 781

9 Maegraith, B G , Andrews W H H & Wenyon, C E M (1949) *Ann trop Med Parasit* 43, 225

10 Taliaferro, W H & Mulligan, H. W (1937) *Indian med Res Mem* No 29

THE LIVER IN MALARIA*

by

B G. Maegraith

1. Enlargement of the liver is common in malaria

In hyperendemic malarial regions such as West Africa enlargement of the liver, especially in young children, is often caused by malaria

There is good evidence that the liver is involved functionally in acute malaria In severe falciparum malaria there may be gross anatomical changes the common autopsy finding is centrilobular degeneration or necrosis[7] (plate 44)

In subjects who have been frequently reinfected or who have suffered from long continued infection, the liver is also commonly involved Descriptions in continental textbooks of so-called 'chronic' malaria in infants and young children usually emphasize the enlargement of the liver although the point is frequently missed in British texts[5]

The anatomical changes which occur in long continued or frequent infection include some atrophic disorganization of the central region of the hepatic lobules and a round cell infiltration of the connective tissue of Glisson's capsule, clearly visible in the portal tracts (plate 45) This infiltration is believed to be related to the presence of some tissue resistance to the parasite[10]

In some of the liver biopsy material from children in Fajara, Gambia†, pathological patterns of this sort are present, often accompanied by pigment deposits in the Kupffer cells I think this indicates that repeated malarial infection was probably responsible for these lesions I believe this is the case in a high proportion of the enlarged livers (particularly when associated with enlarged spleens) seen in children in malarial regions I would like to see more work done on this point. The current surveys in Keneba have already given some confirmatory information[6] Similar information will probably come from Bruce-Chwatt's interesting experiment[4] at Ilaro, Nigeria

The clinical picture of repeated malaria, especially in children, is probably compounded of the pathogenic effect of malaria and of other pathogenic processes including helminth infections and malnutrition The part actually played by malnutrition cannot be assessed until the role of malaria and other agents has been ascertained I think that herein lies the intrinsic importance of the work being done at Keneba by Professor Platt's unit

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* Only two figures from the demonstration are given Other items may be found in the literature quoted - Ed

† Kindly put at my disposal by Professor B S Plat

DISCUSSION

Dr RAO drew attention to certain resemblances and differences between a disease found in India[2,3] and kwashiorkor. In India it was considered that dietary deficiencies might result in lesions in other parts of the body as well as in the liver.

A clinical condition described under different names, such as infantile cirrhosis, infantile biliary cirrhosis and infantile hepatic cirrhosis, occurred in Indian children of about two years of age. In early stages the signs and symptoms were similar to those described in kwashiorkor, namely, listlessness, fretfulness, refusal to take food, and slight enlargement of the liver

He demonstrated examples of the histology of the liver in infantile cirrhosis and summarized the essential differences between syndromes observed in India and elsewhere. In his cases there was necrosis of the hepatic parenchyma which was ultimately followed by cirrhosis of the liver.

He drew particular attention to the production of experimental fatty cirrhosis and the genesis of the fibrosis, and referred to the work accomplished under the auspices of the Indian Council of Medical Research and its specialized committee set up to deal with the problem.

He further demonstrated the effect of deficient diet on experimental animals in order to prove that a low protein intake could produce a marked change in the liver and ultimately lead to cirrhosis

In conclusion, he referred to the experimental work on monkeys fed on a poor rice diet to illustrate the changes in the different organs, and particularly in the gastro-intestinal tract.

In the discussion which followed, Dr Rao[2, 3] said that the pathological changes found in serous hepatosis, as demonstrated by Dr. Waterlow, were not the same as those of infantile cirrhosis in India.

Professor GYORGY referred to a syndrome described by Mauriac which comprised stunted growth, fatty liver, prolonged diarrhoea and diabetes He wanted to know how it differed from kwashiorkor Professor DAVIES said he had never seen diabetes associated with kwashiorkor (Professor PLATT asked when Mauriac had described this syndrome and was told that it was in the late 1930s*) The point was made that some caution was required in attributing the beneficial effects of skimmed milk in cases of kwashiorkor to its protein content. Properties originally but erroneously attributed to certain of the constituents of cod liver oil showed how mistakes

*Probably Mauriac P (1934) Paris Medical, 2 525 - *Ed*

LESIONS OF THE PANCREAS IN KWASHIORKOR

by

R Camain and M Pierchon*

The authors have studied the lesions of liver and pancreas in post-mortem material from 34 patients with kwashiorkor who died at the Central Hospital, Dakar *Plates 48 to 51 illustrate the* various pancreatic lesions

In support of the observations of Waterlow[5], Davies[1] and Hartz[2], the importance and constancy of the lesions of the pancreas have been confirmed The acinar cells are atrophic and calcified and there is loss of tubular pattern the pancreas resembles a sarcoma-like tumour

There is apparently a true increase in the size of the islets The number of α cells appears to be reduced while that of the β cells is increased, a fact which supports the observations of Verne and Hebert[3,4] in their work on the accumulation of fat in the liver of the white rat poisoned with *Amanita phalloides*

Fatty infiltration of the liver usually but not invariably accompanies the pancreatic lesions This fatty infiltration starts in the periportal region It was absent six times out of 34 and remained unobtrusive in eight cases

It seems that the fatty liver changes which have so far attracted most attention might be secondary and that the pancreatic changes in kwashiorkor are remarkably constant

REFERENCES

1 Davies, J N P *(1948) Lancet* 1, 317

2 Hartz, P H *(1949) Docum neerl indon morb trop* 1, 41

3 Verne, J *(1949) C R Soc Biol Paris* 143, 668

4 Verne, J & Herbert, S *(1950) C R Soc Biol Paris* 144, 741

5 Waterlow, J C *(1948) Spec Rep Ser med Res Coun Lond No 263*

* An account of this work but without the illustrations reproduced in this report, will be published in the Bulletin Medical A O F

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could arise Professor Davies said that marasmus meant starvation A kwashiorkor child who had lost the power to digest his food was starving Whether he had passed into that condition could be diagnosed by determining whether the liver was fatty or whether there was general atrophy of the organs If there were atrophy of thè enzyme-secreting glands and a change in the liver such as fibrosis, then the disease would follow the same course as kwashiorkor. He felt that liver changes were not so important as changes in the pancreas. Professor CAMBOURNAC referred to the pathology of the liver in relation to malaria and said that the pathology of malaria had not been so deeply studied as it might have been. Some difference of view existed about the lesions that might occur in the liver caused by malaria.

Dr EDINGTON, commenting on Dr. McGregor's paper, stated that a village of 255 inhabitants in the Gold Coast had been surveyed in 1949-50. The incidence of liver and splenic enlargement in age groups was

	Age - years				
	Under 1	1-5	6-15	16-45	Over 45
Number examined	12	50	66	104	23
Liver enlarged (percentage)	33	58	41	21	13
Spleen enlarged (percentage)	25	86	62	24	17

The incidence of liver enlargement, although less than the incidence of splenic enlargement, followed a similar pattern in age groups. The various factors present in the village were considered (malnutrition, helminthic infestation, etc.) and it was concluded that malaria was most probably the cause of liver enlargement in the younger age groups but that in the older age groups malnutrition could not be excluded as an aetiological factor. In this respect the paper by Dr. McGregor was most important since he had shown that malaria was the cause of hepatomegaly in the Gambia It would be of value to know the pathology of the liver in the protected and unprotected children. A common precursor was a period of prolonged fatty infiltration.

Dr. McGREGOR asked whether there might not be a widely varying number of stimuli contributing to the same end effect Dr RAO said that in the tropics there were many conditions in which a periportal fibrosis might be found in the liver He emphasized the difference between fibrosis and cirrhosis In some cases where chronic fibrosis was found, there might be evidence of malaria It would be fallacious to say that fibrosis was a pathological sign of kwashiorkor and nothing else.

Professor BROCK said he could not speak as a pathologist He had been able with his colleagues Suckling and Thomson, to follow

up some 30 Cape Coloured kwashiorkor cases two or three years after hospitalization and successful treatment. Twenty liver biopsies recently taken showed no continuing pathology of significance. In general he felt that worth-while results might be gained from a more consistent follow-up.

Professor JACQUOT referred to Dr. Balfour's experiments and asked which amino-acids had been used to supplement the experimental diets, which of them had produced positive results, and what were those results in respect of weight and hair-formation. What, for instance, had been the effect of cystine and tryptophan supplements? Lysine, which Dr. Balfour had mentioned as an additive, he regarded as a specific factor in growth.

Dr. BALFOUR replied that she had given supplements of each of the other essential amino-acids in combination with lysine to animals receiving the pennisetum diet. In no case was the response better than with lysine alone, in fact, with a supplement of tryptophan the average weight gain was less. A supplement of casein improved the quality of the hair but did not cure the baldness. There was no improvement when 0 1 per cent cystine was added to the casein supplement.

In answer to a further question from Professor Jacquot concerning the effect of the diets on pregnancy, she said that there had been a failure of lactation but that pregnancies had continued to full term and the young were born normally. She therefore considered lactation to be a more sensitive index than pregnancy.

Professor JACQUOT remarked that the proteins of sorghum and pennisetum were similar to those of maize, in all there was an important deficiency in lysine which was the limiting amino-acid

Dr. EDINGTON said that fatty infiltration in the livers of the new-born had long been observed in the Gold Coast.

In view of a report stating that varying degrees of fatty infiltration of the liver were normally found in the new-born in America[1], the subject was not pursued further. He considered that the exact fat content of the liver of the new-born should be estimated in various conditions and that no conclusions should be drawn from the presence of a 'fatty liver' in the new-born until definite 'normal' figures were available.

Professor JACQUOT thought that progress depended on the post-weaning diet, he had been able to wean a calf after 15 days and obtain a more satisfactory growth rate than with normal weaning.

Dr. PATWARDHAN said that some three or four measurements he had taken of breast milk yields after the second year gave an average of between 25 and 40 c.c. per day.

He recalled Professor Davies's assertion that stellar fibrosis was a characteristic condition of kwashiorkor. Medical literature suggested a relationship between malnutrition in the child and portal cirrhosis in the adult. He would like to ask whether Professor Davies had seen any cases of kwashiorkor in relapse and, if so, whether there was any evidence of an advance in the fibrosis, which in his opinion would eventually lead to portal cirrhosis in the adult stage.

Professor DAVIES said that it was difficult for him to answer that question, since he received cases of kwashiorkor only *post mortem* and usually at a very early age. Véghelyi had said that all relapsed cases were fatal, the fibrosis increasing with each attack. He himself recalled an instance of Ruandi immigrants into Uganda at a time of acute food shortage. They were found to be suffering from pancreatic atrophy, fatty infiltration of the liver and a marked increase in fibrosis. The question was whether they were cases of chronic fibrosis due to malnutrition. He was of the opinion that they were. It was known that fibrosis continued to develop long after the decline of the fatty infiltration. Professor Brock, however, had observed no continuing fibrosis in the cases he had followed up. Similar instances could be found in other parts of the world. In Curacao, for example, cirrhosis was rare; this was not surprising but could not be explained. He did not believe that the fibrosis developed as a consequence of the fatty infiltration, but he could not account for its appearance. In Uganda no cases of cirrhosis in infants were to be found, though there were many cases in the late teens and early twenties. What happened in the interval he could not say.

Dr. PATWARDHAN then said that he had been conducting experiments with deficient diets in India, where millions of people lived on a rice diet comparable with the sorghum and pennisetum diets used by Dr Balfour. The experimental animals showed margination of cytoplasm in the parenchyma of the liver up to between three and six months but no further change up to twelve or fifteen months. Only later some evidence of fatty infiltration could be seen in surviving rats. He wondered what results would be obtained by extending the experiments for a further period. Some further experiments were being carried out along the lines of Dr Lindan's work, to find out how a series of pregnancies affected liver structure when rats were maintained on poor diets. It appeared, as Dr Lindan had said, that a fatty liver was precipitated in the female rat by pregnancy.

Feeding with a rice diet deficient in choline and methionine resulted at first in an increase in the fat content of the liver at two months, reaching a maximum of 11 per cent on fresh weight at four months, but subsequently the fat content fell away gradually to 5 per cent and remained unchanged up to 17 or 18 months. The conclusion was, as Dr. Lindan had suggested, that growth took precedence over liver metabolism, and so, on the methionine-choline deficient diet, the fat content of the liver increased during the growing period.

Professor MONCRIEFF thought that the history of the study of rickets would afford fruitful parallels for when growth was retarded, rickets healed. He suggested that Dr. Lindan's experiments should be carried a stage further. Maximum changes had been observed on the 52nd day. If the animals were thereafter starved and killed it would be possible to discover whether or not the process of liver degeneration was reversible.

He also thought that an undue degree of attention had been paid to liver tissue as compared with muscle tissue, which, after all, constituted about half of the body tissue and was the product of the raw material manufactured by the liver. He deplored the lack of exact knowledge of muscle histology and chemistry, and made a plea for further study in that direction

Professor GYORGY described some experiments which he had helped conduct Two sets of experimental animals, the one normal and the other germ-free, had been fed on identical yeast diets. The normal group had suffered a 100 per cent hepatic necrosis without gain in weight, and had subsequently died In the germ-free animals the growth rate had been normal and weight had risen to between 200 and 300 g.

In another group of experiments, conducted a year or two earlier, a diet which had brought about Hill's* serous hepatosis in Jamaican children was fed to rats, and their growth had ceased. Later a chance sample of the diet which had been sent without dry-ice packing and had fermented, was fed to the rats, growth rate became normal. In each case the protein content of the food was very low.

Similarly, in Guatemala, a batch of food, half of which had fermented and half arrived dry, was fed to two groups of rats. The results were significantly in favour of the fermented diet. The protein content, he noted, had been identical and low (less than 8 per cent) and the difference in growth rate was not due to the cyanocobalamin (vitamin B_{12}) content. The view currently held was that fermentation permitted a more effective utilization of the protein content

REFERENCES

1 Dorkin, J R & Weinberg T (1949) *Arch Path* 48 578

2 Rao, M V R (1935) *J med Res* 23, 69

3 Rao, M V R (1936-7) *J Indian med Ass* 6, 135 190, 304, 363 438 512 567

* See p 186 reference 9

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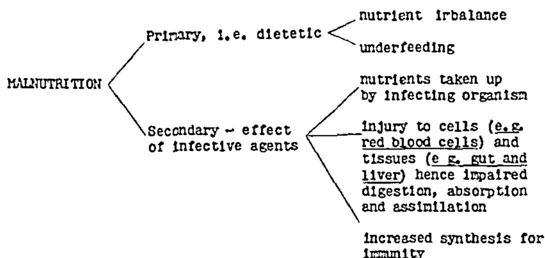
Chairman. Professor E. J. Bigwood

NITROGEN METABOLISM IN MALNOURISHED INFANTS AND CHILDREN

by

B. S. Platt

It may be appropriate in opening this session to review briefly the results of the biochemical work on malnutrition done at Fajara in the past five years I shall use the term 'malnutrition' to include the results of improper or under-feeding, and the secondary effects on the cells of the body of disordered metabolism from various causes as shown in the accompanying scheme.



Malaria is a good example of an infecting agent which may affect the nutrition of the body in the several ways depicted in this scheme

At the beginning of the research on this station, I directed the interest and attention of all my staff to the study of protein metabolism and its disorders Before that time we had already studied methods likely to be of value in investigations of human malnutrition in the Gambia, for example, microrespirometry with the Cartesian diver, isotope techniques, paper chromotography and cytochemical procedures

One of the first quantitative observations to be made was of plasma protein levels, values for total proteins have been reported[1] All now agree that knowledge of the amounts of particular fractions, especially, perhaps, of serum albumin, is desirable. During 1949 and 1950 routine determinations of total proteins were made on 60 children of ages ranging from one to ten years, half of these had levels less than 6 7g per 100 ml Blood samples from the series of

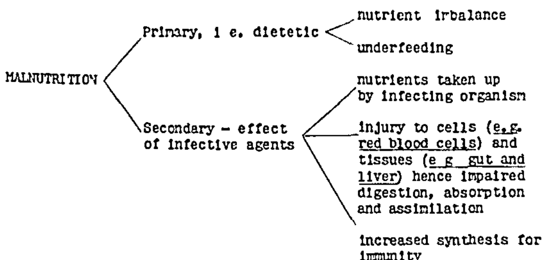
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patients investigated in 1949 were fractionated by the sodium sulphate method The albumin in one patient was 4 6g per 100 ml., the remainder (16 patients) had amounts ranging from 1 2 to 3 5g per 100 ml - mean 2 -g *Normal means obtained by* two different groups of investigators are 3 8 and 4 7g per 100 ml Our results agree with those found by a group of investigators in a series of eight cases of Kwashiorkor in the Belgian Congo [4]

There is a real need for more quantitative data on and study of plasma proteins in malnutrition - especially to determine the extent to which they are affected by infection 'e hope soon to devote more attention to the quantitative aspects of protein synthesis for defence against zymotic agents in disease A promising technique in this study is electrophoresis on filter paper (page 204).

Low blood protein levels may for present purposes be considered as being due to one, or a combination of two or more, of the follo - ing factors

(a) *Insufficiency of the right* amounts or kinds of protein in the diet
(b) Failure to digest and absorb protein from the alimentary canal
(c) Impairment of the function of the liver, which normally synthesizes all plasma albumin
(d) Reduced synthesis of globulins by extra hepatic tissue

Plasma albumin may be utilized more or less directly by body cells in the synthesis of the protein part of enzymes and, in so far as this is the case, the lowered plasma albumin may be accompanied by a reduction in some enzymes of some tissue cells and body fluids However, tissues, such as the pancreas, which are known to be able to synthesize enzymes directly from amino-acids may suffer from a failure of the liver, through lack of plasma albumin, to supply sufficient amino-acids to them Even though they may be independent of plasma albumin as the precursor for such syntheses, an insufficient supply of amino-acids may lead to failure to produce enzymes by these tissues A satisfactory analysis of the relative roles of amino-acids and proteins as precursors of tissue enzymes must await *the use* of materials marked with isotopes

I have spoken of the synthesis of the protein moiety of the *enzyme, we must not overlook the fact that enzymes are complexes* of a protein and a co-fraction There are many enzymes in which one of the members of the group of B-vitamins, or a derivative of one of them, is the coenzyme It is most important to appreciate this *point, for* in it may lie the explanation of apparent insufficiency of a member of the vitamin B-complex in the diet when there is, in fact, no shortage of the accessory food factor Clinically, signs of insufficiency of a member of the vitamin B-complex may be primarily due to deficiency of protein or amino-acids, from which the body produces the protein part of the enzyme complex Moreover, as Pieraerts[8] shrewdly observes, *medicinals, e g* folic acid, often fail to have any effect in the treatment of patients until plasma proteins

have been supplied in sufficient amounts to lead to the subsidence of oedema It would seem, then, that treatment should be directed towards raising plasma albumin levels, and estimation of plasma albumin may well be the most useful monitor of successful therapy to this end Whilst our results of treatment with skimmed milk powder - begun six years ago in Gambian villages, i.e before work on this station began - have generally been effective, it has sometimes been found necessary to give reconstituted dried plasma parenterally

We must not forget, too, that part of haemoglobin is protein and that a reduction in the level of haemoglobin may be a manifestation of dietary insufficiency of protein

Reduction of plasma and liver esterase levels in Gambian infants has been reported[10] and the results of some of his work here and of further studies in Jamaica are described by Dr Waterlow in this Report (page 176) I have made a number of estimations of procaine esterase, many low values have been obtained* I would add that, from the results of animal experiments, one would not expect all enzymes to be reduced† or that those affected would all be reduced to the same extent With increasing knowledge, we may be able to forecast the enzyme systems that might be affected in different metabolic disorders At the present stage of our knowledge we may, for a crude guide, employ the concept that the amount of an enzyme in a tissue is determined by the need for it in the reaction in which it takes part, so that, for example, the amounts of various enzymes involved in protein synthesis may be reduced in amount when protein anabolism is low

May the reduction in amounts of pseudocholinesterase in the plasma be related to a lowering of protein synthesis? A similar enzyme from certain nerve tissue is known to be involved in acetylation mechanisms and may also be concerned in the synthesis of peptides I have found a reduction in acetylation of sulphonamide drugs in patients in whom plasma esterase is reduced More investigations are, however, needed before the full significance of this observation can be appraised Glucuronide formation may occur to replace acetylation Special methods may have to be employed to determine the type of conjugation that occurs Reduction in the amount of acetylation may conceivably be due to insufficient coenzyme A, of which pantothenic acid is a component It has, indeed, been suspected that deficiency of pantothenic acid occurs in African diets Intricate as these interrelationships may be, there is the further complication that it has been shown that methionine and pantothenic acid are interchangeable in the synthesis of protein antibodies We suspect that there is insufficiency of methionine in some African diets

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* Final details of the method of estimation will be published elsewhere

† There is now evidence that the enzyme content of some tissues may be increased in protein malnutrition[9]

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It would be expected that children who had been living for a long time on a diet deficient in protein would show a high retention of nitrogen when fed on a diet containing an adequate amount of protein The nitrogen retentions observed (see table 2) were usually higher than those recorded for American children The low retentions did not appear to be the result of failure to digest and absorb nitrogen since the faecal nitrogen was fairly constant in all cases, but one case with a low retention had a fibrotic liver The children who had high nitrogen retentions did not show the increase in weight which would have been expected in normal children, and the explanation may be that on a good diet the tissues of a previously protein-starved child alter in composition, becoming more concentrated in protein with a simultaneous loss of water.

Table 2

Comparison of the retention of nitrogen in African and American children

Age	Number of cases (African)	Nitrogen retention (g/24 hr) African	American
7	2	1 90	0.46
		1 37	
8	2	0 37	0 62
		1 93	
9	4	0 12	1 05
		1 93	
		2 05	
		3.25	

The distribution of nitrogenous substances in the urine was examined and the proportion of urea found was low compared with that of normal American children Further studies* on infants and young children showed that a low total excretion of nitrogen in the urine was correlated with a low proportion of urea nitrogen Treatment of these infants with a mixture of the B-vitamins had varying effects on the proportion of nitrogen excreted as urea, but when the nitrogen output was raised by giving skimmed milk powder, the proportion excreted as urea was increased (table 3)

* Work is still in progress and is being done in association with Miss Hilary Dewey

It is relevant here to note another reaction analagous to peptide bond formation - the production of hippuric acid after administration of sodium benzoate (hich has been employed as a test of liver function) is also reduced in the malnutrition syndrome in children studied in the Belgian Congo Dr O Lindan has had similar results with a small series of patients on the Field Research Station at Fajara

Since I began to work in African villages fifteen years ago, I have never ceased to wonder at the striking transformation of weedy boys and girls into lusty youths and buxom maidens There is no doubt, as I shall show later, that judging from their size and eight at various ages they are stunted or retarded in growth There is confirmation that development is retarded, from radiological appearance of ossification centres in the skeleton In the early part of the century before the period in which biochemists and nutritionists were almost completely engrossed in the study of accessory food factors, a good deal of work was done on the effects on the growth of animals of restricted diet[6] It is of particular interest in relation to my observation on the striking changes which occur after adolescence that in one investigation in which marked reduction in weight of the testes was observed during stunting, increases above normal weights were obtained when animals were transferred from a restricted to a good diet[7] There has been renewed interest in recent years in the effects of restricted feeding on endocrine activity and there is evidence that when animals kept on a diet of low energy value have highly active pituitary-adrenal-cortical hormone mechanisms they have a lowered secretion of gonadotropic hormones as shown by the decrease in weight of the ovaries and uterus and the cessation of oestrus[2]

A study[3] of some Gambian children of seven to nine years of age showed that they were underweight in comparison with American children of the same ages The results of determinations of nitrogen balance on eight boys showed that their protein intake was low for their ages although (see table 1) the amount of food eaten per kilogram of body weight was almost the same

Table I

Comparison of the protein intake of African and American children

Age	Protein intake			
	g/day African	g/day American	g/kg body wt /day African	g/kg body wt /day American
7	48	65	3 0	2 9
8	52 5	74	2 8	2 8
9	53	82	2 4	2 8

This loss of nitrogen from the gut may be due to either impaired digestion and absorption of dietary protein following a lowered synthesis and secretion of pancreatic and intestinal enzymes or an increase in the amount of metabolic nitrogen excreted as a result of the effect of low protein supplies on the metabolism of the proteins of the gut wall itself.

Preliminary studies have been made on the tryptic activity of the pancreas and on nitrogen digestibility in rats in which the protein metabolism had been upset by daily injections of the antimetabolite ethionine Tryptic activity of the pancreas and apparent nitrogen digestibilities were lowered by the tenth day Pair fed control animals also showed low nitrogen digestibilities and as ethionine greatly reduces the appetite these may have been due to the low intake of food

Turnover rates of the gut wall proteins are higher than those of the pancreas so that the intestinal glands may be affected by low protein supplies even earlier than the pancreas, which is known to be affected before the liver Further studies on the effect of protein deprivation on some intestinal enzymes are being made since it seems that these may be some of the first to be affected in protein insufficiency

REFERENCES

1 Barakat, M. R. & Smith, D. A. *(1949) Lancet*, II, *12*

2 Boutwell, R. K., Brush, M. K. & Rusch, H. P. *(1948) Amer J Physiol*, 154, *517*

3 Bray, B. *(1953) Brit J Nutr*, *7*, *3*

4 Dricot, C., Beheyt, P. & Charles, P. *(1951) Ann Soc belge Med trop*, 31, *581*

5 Fleming, G. B. & Hutchison, H. S. *(1924) Quart J Med* 17, *339*

6 Jackson, C. M. *(1925) The effects of inanition and malnutrition upon growth and structure Churchill, London, p 409*

7 Jackson, C. M. & Stewart, C. A. *(1920) J exp Zool*, 30, *97*

8 Pieraerts, G *(1950) Bull Soc Pat exot*, 43, *120*

9 Waino, W. W, Eichel, B., Eichel, H. J., Person, P., Estes, F L. & Allison, J. B. *(1953) J Nutr*, 49, *465*

10 Waterlow, J. C. *(1950) Lancet*, I, *908*

Table 3

Relation between the total output of nitrogen in the urine and the amount excreted as urea for American and African children, showing the effect on young African children of feeding skimmed milk powder

	Number of cases	Mean total urinary N g/24 hr	Urea-N x 100 / Total N
American children			87
African children 7 to 9 years	8	5 9	75
1 to 4 years	6	2 08	56
1 to 4 years	8*	4 16	80

* These subjects had a daily supplement of skimmed milk powder (about 0 33g N per kg body weight per day) from 4 to 41 days

The effect of a lowered nitrogen metabolism on the synthesis of enzymes which has already been discussed might be expected to lead to low digestibilities The ubiquity of diarrhoea and the occurrence of high levels of faecal nitrogen in young children led us to make some measurements of digestibility Simple diets of rice and skimmed milk powder were given and the digestibility of protein was determined at different levels of nitrogen intake, using chromic oxide as an indicator (see page 212). Low 'apparent' nitrogen digestibilities were found compared with those of European infants on similar nitrogen intake who were studied after their diarrhoea had subsided[5] (table 4).

Table 4

Comparison of faecal nitrogen of Gambian children with others at similar levels of intake

	No of cases		Nitrogen (g/24 hr) Intake	Faecal output	Apparent N digestibility %
Gambian children 2 to 5 years	5	Range Mean	2 36-4 90 3 68	1 10-2 22 1 37	53 3-75 1 58 1
European marasmic* infants	11	Range Mean	2 39-4 83 3 96	0 41-0 86 0 57	74 0-89 9 85 0

* see reference[5]

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3 Bray, B. *(1953) Brit J Nutr*, 7, *3*

4 Dricot, C., Beheyt, P. & Charles, P. *(1951) Ann Soc belge Med trop*, 31, *581*

5 Fleming, G. B. & Hutchison, H. S. *(1924) Quart J Med* 17, *339*

6 Jackson, C. M. *(1925) The effects of inanition and malnutrition upon growth and structure Churchill, London, p 409*

7 Jackson, C. M. & Stewart, C. A. *(1920) J exp Zool*, 30, *97*

8 Pieraerts, G. *(1950) Bull Soc Pat exot*, 43, *120*

9 Waino, W. W., Eichel, B., Eichel, H. J., Person, P., Estes, F. L. & Allison, J. B. *(1953) J.Nutr*, 49, *465*

10 Waterlow, J. C. *(1950) Lancet*, I, *908*

CONSIDERATIONS OF PROTEIN DEFICIENCY IN UGANDA

by

E G Holmes

It is easy to appreciate why the health of mothers and children should be the special subject of this Conference if it is assumed that malnutrition in infancy, and perhaps even before birth, may account for ill health and physical inefficiency in adult life. The writer agrees with this assumption but insists that in the present state of knowledge it cannot be regarded as being more than an assumption It is necessary also at the outset to stress our lack of fundamental information about the details of the nutrition, growth and general health of the African and to express the hope that a start will be made with the necessarily laborious and expensive process of obtaining information on these matters. Without such knowledge, progress will be hampered in many ways, not the least in that of devising effective preventative measures. Accurate information is also needed on the numbers of children in East Africa, birth and infant mortality rates, the chief causes of infant mortality and morbidity, and the amounts and kinds of food eaten by infants and children

The information on which the following considerations are based has been obtained by the writer from various sources, it has almost always been obtained under great difficulties and from an insufficient number of observations. Those who supplied it would be the first to agree that it must be treated with considerable reserve.

Mothers, infants and toddlers

It is the general impression of observers that signs of malnutrition are seldom seen before the age of six months, up to which time the infant is adequately nourished by the mother's milk. Suckling is often continued for long after this, but the supply of mother's milk becomes progressively less adequate for the needs of the child, who becomes more and more dependent both for protein and calories on the supplements which it is given I am indebted to Dr Hebe Welbourn for the data (table 1) obtained at her infant welfare clinics in Uganda

Table I

Relationship between ages of infants breast feeding and the occurrence of malnutrition

Age group (months)	No of children	Percentage breast-fed	Percentage having signs of malnutrition
- 1	36	100	0
- 6	222	93 7	0
-12	192	87 5	3 7
-24	211	61 1	5 1
-36	145	6 2	7 6

These children are selected to the extent that the mothers were sufficiently intelligent to make use of the clinic The type or quantity of food given to supplement, and later replace, the breast milk, has not (so far as is known) been the subject of accurate study. Welbourn, in common with other observers, believes that it is almost invariably a pap made from matoke (plantain), lumonde (sweet potato) or maize meal, with or without sauces made from vegetables and/or groundnuts

It must be remembered that it is on the whole unlikely that among an uneducated population any special effort will be made to provide children with articles of diet which, by reason of expense, are rarely, if ever, part of the household dietary In much more advanced and wealthy communities the proper feeding of infants has only been achieved relatively recently by much education and propaganda. Certainly in Africa the head of the family enjoys the right to the best, and most, of the available food In this connection it is perhaps not out of place to quote some figures for adult diets. These are calculated from a report dealing primarily with the cost of living in Kampala*[5] The figures for food consumption have been obtained by dividing the stated monthly expenditure on various articles by the prices quoted at the time of the survey, ten per cent has been deducted from the figures for wastage in preparation and cooking The number of individuals observed was 110, and the period of observation, 30 consecutive days. The average daily food intake per individual was (to the nearest integer) protein 53g, carbohydrate 515g, fat 42g, Calories 2,647 Only 9g of protein was of animal origin, milk, eggs, butter and cheese did not appear in the dietary On the other hand, 23g of the protein were derived from maize, cassava, plantain and sweet potato The amino-acid composition of the protein of plantain and sweet potato is not known, their protein content is, however, less than two per cent The calorie intake would suffice for moderate but not for heavy work If the bread-winner consumes a diet of this kind, it is unlikely that the women or children of the household will do very much better

Pregnancy

It is stated in most textbooks that during the last three months of pregnancy a woman requires 30g of protein over and above her normal intake, and about 350 additional Calories per day During lactation she should receive additional protein and calories at least equivalent to those lost in her milk, that is, about 40g of protein, and about 450 Calories daily The demand of the new-born child will increase as it grows

The protein content of the staple foods is so low that sufficient bulk to provide the additional protein could not be consumed It

* I am indebted to the Head of the East African Statistical Department Dr C J Martin, for the report of the survey which was carried out by his staff

seems essential that we should discover definitely whether or not pregnant and lactating women do take special supplements (e.g. of beans or groundnuts). If they do, it remains to be shown that this extra protein is, in fact, absorbed and contains the necessary amino-acids. If they do not, we are at once faced with a gross dietary defect, the remedying of which is of the first importance. Anaemia, it may be noted, is frequently observed among pregnant women.

The food requirements of children are relatively greater than those of adults as they require food, including protein, for growth as well as for bodily activities.

Their requirements are said to range from 1,000 Calories for years 1 to 2, to 2,900 for years 12 to 14 that is to say, between the 12th and 14th years, the energy value of the food of a child should be the same as that for an adult, and greater than that which the African working adult appears to obtain. A kilogram increase in body weight involves the assimilation of above 300g of protein, which will, of course, be in addition to normal maintenance requirements. It is, therefore, probably impossible for a child living on a diet of the type given to obtain sufficient protein for its needs for normal growth. It follows that very special efforts may be needed to make more suitable foodstuffs available, and to educate parents to give them to children

As disease is traditionally attributed to witchcraft or the malevolence of offended ancestral spirits, it is encouraging that both Dr. Ladkin and Dr Welbourn find that mothers are fairly easily convinced that children should have cow's milk. The difficulty usually lies in obtaining the funds from the family budget There is, however, insufficient cow's milk available (at any price) for more than a small supplement to the diet, and recourse to plant protein of some kind will probably be necessary.

It must, of course, be realized that the dietary habits of the people, and the foodstuffs locally available, differ widely in the East African territories and even within Uganda itself. In general, around Kampala children do not seem to play much, and they make little noise they seldom use even the primitive toys which most children make naturally if left to themselves But it is said that in certain districts they are much more noisy and energetic, and in some of these places at least, millet and beans, rather than plantains and sweet potato, are the staple diets Welbourn's observations[14], as well as others to be mentioned later seem to establish the fact that in both sexes Baganda children are smaller and lighter than London children they compare still less favourably in height and weight with European children living in Kenya

Schoolchildren

It is stated* (no accurate figures exist) that rather more than half the boys and less than half the girls in Uganda attend school. The proportion of schoolchildren in different districts varies greatly. Children of less than six years are not accepted at school, many do not begin to attend before ten years of age. They may remain from four to six years (often for much shorter periods) after which a very small proportion go on to secondary schools.

It is estimated that not more than half the children receive any food before leaving home in the morning. On their return they receive, at any time from 4 to 9 p.m , a meal which is usually bulky and consists chiefly of the high carbohydrate - low protein foods. The schools are encouraged to grow food to provide mid-day meals, but no funds are available for purchases, e g. of milk. At the best, therefore, the schools can provide only vegetables, often cassava or sweet potato, though it is said that in fact it is rare for any food at all to be grown. Children are encouraged to bring food with them, but they seldom do so.

Children have to walk to school, and some walk as many as 24 miles (39 Kilometres) a day. The writer has not found data about the energy cost of walking in the case of children† It is stated in current textbooks that an hour's walking on the level at 3 m.p.h. (5km p h.) (much of East Africa is hilly) costs an adult about 250 Calories. Faster walking entails more than a proportional increase in energy expenditure. An adult would, during a 6-mile walk, expend more than a sixth of the energy (2,647 Calories) supplied by the customary diet. Although the child is lighter than the adult, its basal metabolic rate is higher, and physiologically its energy expenditure and protein intake should be devoted primarily to the processes of growth. It seems, therefore, unlikely that the proportionate cost of walking will be less to the child than to the adult. The girls are expected to carry out household duties (e.g. carrying wood and water) when not at school. If the child's food intake is inadequate, and if in addition it has to expend a considerable proportion of its energy on walking to and from school, much of the money spent on education in East Africa is probably wasted because the child is too exhausted to learn.

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*Personal communication from Miss H Neatby of the Education Department and Dr Ladkin

†The Calories expended per hour by a boy or by a girl weighing 70lb (32kg) walking at moderate speed are 178 and 165 respectively (Report of the Bureau of Human Nutrition & Home Economics 1952 U S Department of Agriculture) - Ed

Hospital cases

A considerable number of children are admitted to hospital suffering from kwashiorkor, which is believed to be essentially a condition of protein deficiency If untreated, the disease is often fatal, but treatment combining the elimination of associated infections or parasitic infestations and the administration of a high protein diet is successful in the majority of cases We do not, however, know (a) what proportion of the total cases of frank kwashiorkor occurring are admitted to hospital, (b) how many children who have never been seen by a doctor are suffering from major or minor degrees of the condition, and (c) whether there are effects, either in treated or untreated cases, which last into adult life Thus, the observed frequency of appearance of the condition in hospital is an inadequate guide to its occurrence among the child population

Biochemical observations on infants, children and adults

It is proposed to discuss here some biochemical findings in the disease the clinical and pathological features are fully considered elsewhere in the Report Broadly speaking, the biochemical changes are consistent with the picture of protein deficiency, and they are at least partly reversible by the administration of a high protein diet

A most important series of observations has been made by Thompson[11 12] By means of an aspiration technique, she has obtained samples of the duodenal contents of children The content of the digestive enzymes, amylase lipase and trypsin, in the duodenal secretions has been determined in children with kwashiorkor, before and after treatment, and in children with non-nutritional diseases A deficiency of all three of the digestive enzymes has been found in kwashiorkor, and with successful treatment of the disease the levels of the enzymes rise and may even exceed those of the controls

The failure of digestion of foodstuffs which would follow a deficiency of digestive enzymes is in full accordance with the constantly observed clinical features of the condition, and also with the pathological observation that the cells of the pancreas invariably show marked degenerative changes when examined *post mortem* in fatal cases

The most efficient method of restoring the enzyme levels is by feeding with skimmed milk in large amounts a preparation of soya bean protein is also effective but maize protein is of little use

In adults, a similar diminution of digestive enzymes during malnutrition and a similar restoration on protein feeding has been demonstrated

Studies on circulating enzymes and a number of blood constituents have been made subsequently by Dean and Schwartz[3]

The late effects of the disease, if any, on children who survive attacks of Kwashiorkor may be of even greater importance as a public health problem than the fact that numbers of fatal cases of the condition occur in childhood It is, of course, much more difficult to obtain clear evidence about these persistent after-effects than to investigate the features of frank cases of the condition and to devise treatment for them

The work on African nutrition of the writer and his immediate collaborators has been directed to the study of adults rather than of children If, however, it can be assumed that protein deficiency in childhood leads to ill health in later life - and it has already been pointed out that such an assumption must at least tacitly be made - studies on adults must surely be germane to the main theme of this Report

Dean[2] has made a number of observations on adolescents in the Budo School near Kampala This is a large school for both sexes, with primary and secondary sections Its status is (roughly) equivalent to a 'Public' School in England or a 'Private' School in America, i e the pupils come from the upper social and economic strata of African society Briefly, Dean found that 180 secondary school boys, supposedly about 18 years of age, were on the average 3 in (7 6cm) shorter and 14 lb (6 4kg) lighter than United States boys of the same age, pubic and facial hair was less than expected, 3 3 per cent had considerable gynaecomastia, and the general shape of their bodies tended towards the feminine rather than the masculine No evidences of dietary deficiency, past or present, were observed in the school

The girls in the primary section were well grown and up to American weight but 2 in (5cm) less in height than American standards The boys were, by American standards, below weight and 2½ in (6 4cm) short in height

Development of carpal and metacarpal bones was normal in the girls, and the boys were slightly in advance of American standards, while the shape and proportions of their second metacarpal bones were characteristic of those of girls and not of boys These deviations from normal may or may not be the result of early defects in nutrition It should, however, be emphasized that these children came from the wealthier strata of society

It seems to be generally agreed that a moderate anaemia is observed in protein deficiency in children and adults, and an anaemia, often resistant to all forms of treatment, is commonly associated with liver lesions Owing, however, to the frequency with which anaemia due to other causes is observed in East Africa it is dangerous to ascribe the condition to nutritional causes unless all others can be eliminated We have, for instance, observed that while the mean red blood cell count of Makerere students is 5 99 ± 0 521 millions per cu mm[9] a value which is in agreement with that observed in other parts of the world at 4,000 ft (1,220m) above sea level,

Hospital cases

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determination nor electrophoresis alone can give us any information about its biological properties, which is the point which at present interests us most. This affords a good illustration of the need for critical evaluation of the methods available for serum protein determinations.

In addition to our observations on presumably 'normal' persons, we have carried out a prolonged series of investigations (still in progress) on hospital patients Some of these patients were suffering from apparently uncomplicated hookworm anaemia, others, without hookworms, from liver damage. They have been placed on a diet containing some 3,000 to 3,500 Calories and 120 to 150g of protein, the latter provided mostly by dried separated milk, and meat It was, of course, expected that they would retain nitrogen in these circumstances What was not anticipated was the extent and duration of the nitrogen retention which we have observed This has continued at the rate of from five to ten grams of nitrogen per day for many months We have, in fact, not yet succeeded in getting any of our subjects into nitrogen equilibrium on these high protein-high calorie diets, although we have, at various stages, brought them into equilibrium by lowering the protein intake In most cases, after four or five months it has been impossible to retain the patients in hospital for further observation The hookworm cases were wormed and treated with iron at an early stage The red blood cell counts increased usually to six million cells and the patients, by clinical standards, completely recovered Two cases, however, both with liver damage proved at biopsy (in one the damage was relatively slight in the other, severe) have been under observation, the one for 1? and the other for 22 months They are still retaining nitrogen They were also found to be in positive phosphorus balance Unfortunately, it was not possible to determine calcium balances at the same time The observations on phosphorus balance were carried on over a shorter period than those on nitrogen balance All patients have shown marked clinical improvement following prolonged high protein intake

We have found no records in the literature* of the retention of nitrogen being prolonged for periods of this order among persons 'rehabilitated' after starvation But Cook and Van Auken[1] have recorded eight cases of Laennec's cirrhosis who, on a high calorie - high protein diet retained nitrogen for many months Most of these, like our own cases became unco-operative before the observations were concluded, but one (an officer who was an ex-Japanese Prisoner of War) came into nitrogenous equilibrium after two years These authors record that the observed changes in weight did not correspond to the nitrogen retention A very puzzling feature of our own observations has been a similar finding We have often observed an initial loss of weight, followed by a gain, after which the weight

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* See, however, page 153 - *Ed*

that of a group of 343 adult male Africans living in and around Kampala was 5 28 ± 0 670 millions[8] Further, when this group was divided according to occupations, the mean count of the group of 'labourers' was 5 05 millions There were indications that the lower red blood cell counts of this group of 343 subjects, as compared with the Makerere students, were associated with their poorer diets, but as it was impossible at the same time to determine the incidence of hookworm infestation among them, a relationship between red blood cell count level and diet cannot be firmly established

In a recent paper[10] results have been given of haematological investigations combined with a study of serum proteins

Our investigations of the serum proteins confirmed the findings of a number of other workers, namely, that among Africans the serum albumin tends to be low and the serum total globulin high, in comparison with generally accepted standards[4 10,13] The albumin values for 86 Africans were lower than those of African Makerere students and Europeans The α- and γ- globulin values of all the Africans examined were higher than those of the Europeans β-globulin values of Europeans were higher than those of Africans

The values for α- and γ- globulin for Makerere students were intermediate between those for the other Africans and the Europeans The students' diets were known to be fully adequate both with regard to calories and protein, and their general health, and the hygienic conditions in which they lived, were known to be good

A further observation[10] was made, which we believe to be new A correlation was found between the values for red blood cell count and for serum protein by chemical estimation, as the red blood cell count increased, the serum albumin rose, and the total globulins fell, due almost entirely to a fall in the β- fraction, the α- - and γ- fractions apparently remaining nearly constant over the whole range of red blood cell counts

We have recently been using electrophoretic instead of chemical fractionation for serum protein determinations The rise of albumin and the fall in total globulin with rising red blood cell count has been readily confirmed Judged by electrophoresis, however, it was not the β- globulin (as the chemical methods indicated) which decreased as the red blood cell count rose, but a fraction which migrated in the Tiselius apparatus with the gamma - globulins In the method for chemical fractionation γ- globulins were precipitated by ammonium sulphate If, after precipitation, they were removed by centrifugation, and the clear supernatant fluid dialysed to remove ammonium sulphate, a further precipitate appeared When this was re-dissolved and submitted to electrophoresis, it was found to contain (in African sera, and particularly if the red blood cell count was low) not only the expected β - globulins but also a fraction showing the characteristics of γ - globulin, which the ammonium sulphate had failed to remove This is clearly the fraction with which we have been concerned It will be noted that neither chemical

This patient was for a short period given a diet containing protein in the form of meat His total protein, albumin and globulin all increased He was wormed and kept under observation. He refused to take milk, and a fall in total serum globulin occurred, the albumin remaining unchanged He was then given iron The red blood cell count immediately rose, but the serum albumin fell steeply His oedema became worse and his general condition deteriorated We interpret this as indicating that haemoglobin formation carries a 'high priority' and, if iron is available, can go on at the expense of circulating albumin, and even at the expense of the organism as a whole This recalls some earlier observations[7] Subsequently, on increasing the protein in the diet by giving meat both serum albumin and serum globulin rose. Thereafter, the albumin continued to rise, and the globulin began to fall The initial rise in both albumin and globulin has occurred in all cases which were severely ill on admission In the apparently uncomplicated hookworm cases, this has always been followed by a fall in total globulin and a rise in albumin, though the patients have insisted on discharge when the albumin was still far below, and the globulin far above the levels shown by the students Their red blood cell counts, on the other hand, had in all cases risen well above five million

Figures 2 and 3 illustrate cases in which there was liver damage proved by biopsy, the first severe, the other slight* Both have retained nitrogen steadily and one (August 1952) is still doing so One case illustrated in figure 2 shows the following features

> After a preliminary rise, the red blood cell count showed little change for a long time It was unresponsive to iron, liver and cyanocobalamin (vitamin B_{12}) However after more than 550 days observation, and at a time when no iron, liver or other haematinic substance had been given for many months, the red blood cell count rose steeply By chemical determination it was found that after a preliminary rise of both fractions, the serum proteins remained fairly constant for some time, after which the albumin and globulin both fell After 350 days, chemical estimation of the serum albumin began to show a slow rise, and serum globulin a slow fall But when measured by electrophoresis the albumin appeared to be much higher than the chemical determinations indicated

Observations such as these again emphasize the need for caution in the interpretation of serum protein changes

Figure 3 illustrates the course of a case with apparently relatively slight liver damage Here there is a slow rise in red blood cell count The protein fractions show considerable fluctuation The sharp initial rise in serum proteins is absent, but unlike the other, this patient was not acutely ill when he first came under observation The behaviour of the serum proteins is, in general, similar to that displayed by Case 2, and unlike that shown by Case 1

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* I am indebted to Dr H C Trowell for performing the biopsies and Professor J N P Davies for reports on the sections

remained remarkably steady We conclude that the protein deposited replaces some other body constituent probably water, possibly also fat With regard to water, we have found that in these cases the extra-cellular fluid may amount to 40 per cent of the body weight ('control' figures which agree with those in the literature are 20 to 23 per cent) and that it falls progressively We are also investigating the total fluid volume With regard to fat, all that can be said at present is that at autopsies on subjects dying in Mulago hospital from malnutrition it is usual to find considerable amounts of fat in the usual situations

Changes have been determined in red blood cell counts and serum protein concentrations, for the most part estimated by chemical methods, since equipment for electrophoresis has only recently become available Data for an apparently uncomplicated case of hookworm anaemia are shown in figure 1

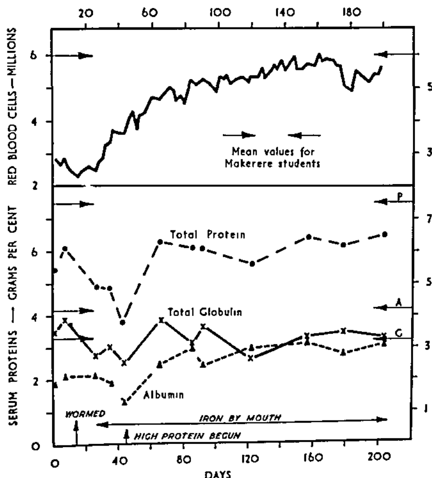


Fig 1 Red blood cell and serum protein changes in a patient with an apparently uncomplicated hookworm anaemia

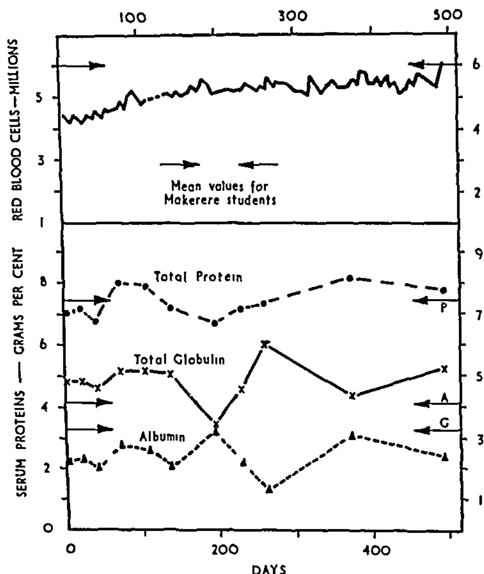


Fig 3 Red blood cell and serum protein changes in a patient with slight liver damage

commonly accepted as normal In Cases 2 and 3, liver damage was proved by biopsy No biopsies were done on the other cases, so that we cannot say whether or not their livers showed histologically detectable lesions It is not, however, even certain that a liver which is histologically 'normal' is necessarily capable of carrying out all its normal functions Some unpublished observations of the writer made in 1938, reference to which is made elsewhere[6], showed, for instance, that the livers of animals injected with diphtheria toxin were unable to deposit liver glycogen after an injection of lactate or pyruvate at a stage of toxaemia in which no lesion was

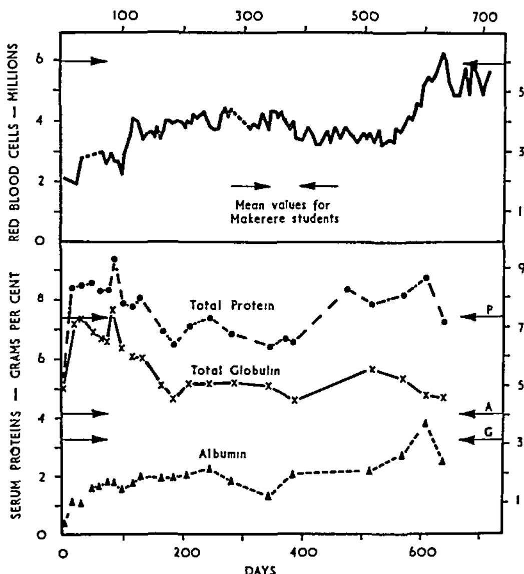


Fig 2 Red blood cell and serum protein changes in a patient with severe liver damage

It might at first sight be argued that these cases illustrate on the one hand (Case 1) the effects of severe hookworm infestation and protein deficiency in an otherwise healthy adult, while Cases 2 and 3 illustrate the effects of liver damage, and this may be the correct interpretation But it will be noted that so far at least as our observations could be extended, even in Case 1 (which is typical of a number of others which we have studied) the serum albumin never rose to the mean level of that of the Makerere students, while the total globulin remained considerably above the students' total globulin and it will be remembered that the students' globulin level is itself significantly greater than that

Table 2

Results of blood examinations of students after periods on home and college diets

	After three months vacation	After six months at Makerere
Red blood cells (millions per cu mm)	5 69	6 05
Haemoglobin (g per cent)	15.83	16 64
Serum albumin (g per cent)	3 10	4 19
Serum total globulin (g per cent)	3 31	3 34

(These changes are statistically significant)

Summary

In the first part of this paper an attempt has been made to consider the factual information at our disposal about the nutrition of mothers, infants and children in East Africa. It is pointed out how little is known with certainty about the subject, and how necessary it is that more, and more accurate, information should be obtained Such information as we have suggests that diets are very deficient, especially in protein It is pointed out that it is essential to be certain that dietary deficiencies in childhood do, in fact, leave a legacy in adult life

Results of recent investigations of biochemical changes seen in children admitted to hospital with the diagnosis 'kwashiorkor' are briefly discussed These show that there is a deficiency of enzymes, both in the alimentary tract and in the circulation There are changes in serum proteins, in the blood urea, and in other blood constituents

Some consideration is given to biochemical studies on adults These have shown changes in serum proteins, even in apparently 'normal' persons In hospital cases, there is also evidence of very large and prolonged nitrogen retention on a high protein-high calorie diet

The question is raised as to whether these findings must be related purely to episodes of malnutrition in adult life, or whether they may be related to a legacy of tissue damage following malnutrition in childhood

The writer acknowledges his very great indebtedness to his collaborators Miss M. W Stanier has carried out the major portion of the work on serum proteins, and has made many helpful suggestions and criticisms Mr E R. Jones has been especially engaged on the nitrogen balance experiments To Mr E Benton I am indebted for a great deal of skilful work in the maintenance and construction of

detectable histologically, though later other biochemical changes occurred and obvious histological lesions developed. The possibility, therefore, cannot be excluded that all three cases portray, in reality, different degrees of the same patholcgical condition.

It remains to be considered how far these observations are relevant to the main theme of this discussion It could be maintained that the liver damage, the avidity of the tissues for protein, and the anaemia, are related to episodes of infection, infestation and protein deficiency in adult life, and have no bearing on malnutrition in childhood Direct evidence on this point, of course, cannot be obtained, since no-one can give a dietary history of the first few years of his life In any case, it is only reasonable to suppose that, even if the adult subject carries tissue damage as a legacy from childhood, those which we have observed have, superimposed upon this, further injury arising from episodes in later life The following points, however, suggest that there is a direct connection between early protein deficiency, and the conditions later observed

(a) In studies on malnourished subjects in other parts of the world, reduction of serum proteins has often been observed, but this is commonly a reduction both in albumin and total globulin Most workers in Africa, ourselves included, report a high globulin and a low albumin without much change in total protein

(b) Increased serum globulins, on the other hand, are associated with liver damage

(c) All observers agree that protein deficiency in childhood is associated with liver damage It is also generally accepted that liver damage is an extremely common finding among African subjects, both at biopsy and at autopsy

(d) It will be recalled that Dean and Schwartz[3] found a rise in serum proteins affecting both albumin and globulin fractions in children suffering from protein deficiency this occurred in a few weeks In the adult cases which were acutely ill when first observed, there has been a similar rise in both fractions at first, which has been followed by a very much slower rise in albumin with a fall in total globulin

(e) The Makerere College students were perfectly normal clinically, and were living under excellent nutritional and hygienic conditions They, however, showed a significant difference in their serum protein pattern from that of the European controls, though it was less extreme than in the other group of Africans Fifteen students were exami[ned] first at the end of a three months vacation spent at th[eir] homes, and later, after six months at Makerere, w[i]th the results shown in table 2 One interpretation of table 2 is that the findings reflect a contrast between th[e] students' diets at home and at Makerere

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REFERENCES

1 Cook, W. R. & Van Auken, H. A. (1951) *Ann intern Med* , 34, 1404

2 Dean, R. F. A. (1952) *E Afr med J* , 29, 1

3 Dean, R. F. A. & Schwartz, R. (1953) *Brit J Nutr* , 7, 131

4 Dricot, C , Beheyt, P. & Charles, P. (1951) *Ann Soc belge Méd trop* , 31, 581

5 East African Statistical Department (1952) *The pattern of income and expenditure and consumption of African unskilled labourers in Kampala Mimeograph*

6 Holmes, E. G. (1939) *Physiol Rev* , 19, 439

7 Holmes, E. G (1945) *Brit med J* , ii, 561

8 Holmes, E. G. & Gee, F. L (1951) *E Afr med J* , 28, 297

9 Holmes, E. G., Gee, F. L., & students (1950) *E Afr med J* , 27, 360

10 Holmes, E. G., Stanier, M W., Semambo, Y. B. & Jones, E. R. (1951) *Trans R Soc trop Med Hyg* , 45, 371

11 Thompson, M. D. *This Report*, p 208

12 Thompson, M. D & Trowell, H. C (1952) *Lancet* i, 1031

13 Van Oye, E. & Charles, P (1951) *Ann Soc belge Med trop* , 31, 701

14 Welbourn, H F. (1951) *E Afr med J* , 28, 428

NITROGEN BALANCES IN NORMAL HEALTHY ADULTS

by

V. N. Patwardhan

Results of nitrogen balance studies on normal healthy adults - students and staff of a medical college and two research institutions - with no history of protein deficiency were similar to those obtained in Africa by Platt[4] studying malnutrition in children and by Holmes[1] studying malnutrition in adults Variations in urinary nitrogen at a constant level of protein intake appeared to depend on the proportion of animal protein in the diet It was clear that nitrogen had not entered into the tissue, for weight had changed little over the 100 days during which the observations had been made Data[2,3] for nitrogen intake and for nitrogen in faeces and urine demonstrated the fact that the variations in faecal nitrogen observed on vegetable and animal protein diets were so small as to suggest that there were no marked differences in the two types of diet The surprising and puzzling feature was that an increase in the proportion of animal protein in the diet increased the urinary nitrogen, and conversely, a predominantly vegetable protein diet gave rise to high nitrogen retention owing to a decrease in urinary nitrogen The phenomenon bore no relation to malnutrition or body weight (increased nitrogen retention was not accompanied by increased weight). It could not be explained along conventional lines, it was probable, therefore, that it was to be accounted for by some factor as yet undetected The high retention of nitrogen in Indian and African subjects was probably not a true retention There were probably some factors which determined the level of protein utilization and which appeared to depend upon the source of dietary protein

REFERENCES

1 Holmes, E. G. *This Report*, p 160

2 Karambelkar, P. V., Patwardhan, V. N. & Sreenivasan, A. (1950) *Indian J med Res*, 38, 241

3 Patwardhan, V. N, Mukundan, R., Rama Sastri, B. V & Tulpule, P. G. (1949) *Indian J med Res*, 37, 327

4 Platt, B. S *This Report*, p 153

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2 Dean, R. F. A. (1952) *E Afr med J*, 29, 1

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4 Dricot, C, Beheyt, P. & Charles, P. (1951) *Ann Soc belge Méd trop*, 31, 581

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deficiency of protein or its components is likely to have important effects on the enzymatic make-up of the cell This has, in fact, been shown experimentally in a number of laboratories In animals which are starved, or kept on a diet low in protein or single amino-acids, there may be profound changes in the pattern of liver enzymes some seem to be labile, others selectively preserved[3, 15, 18, 20, 26, 27] One could perhaps regard this as failure to renew enzyme molecules for lack of component parts However, no clear picture, with physiological meaning, has yet emerged from this work We cannot explain why a particular enzyme is reduced under given conditions It has not been shown, for instance, that sulphur amino-acid deficiency causes a specific loss of sulphydryl enzymes Nevertheless, in general, these experiments make it reasonable to suppose that in man, as in animals, deficiency may cause qualitative changes, if not actual disruption, in the enzymatic machinery of the cell

Another possible effect of malnutrition on enzymes is a 'disuse atrophy' Potter[17], discussing the purpose and justification of enzyme assays, wrote 'The determination of the amount of enzyme in a cell would have no value whatsoever, were it not for the fact that the amount of an enzyme is probably closely related to the extent of its use' He was considering the enzyme pattern in relation to cell growth and specialized function It is only a short step from this idea to the possibility of a loss of enzyme from disuse - lack of substrate - the converse of the adaptive enzyme formation that is known to occur in bacteria, and of which there are perhaps examples in mammalian tissues[10] It cannot be assumed that the cell can lose one of its functions and remain normal in all other respects I think it is more than coincidence that in kwashiorkor where protein deficiency plays a prominent part, the clinical and pathological evidence shows that the organs most affected - pancreas, gut and liver, - are those which normally form much new protein, and are known, on physiological grounds and from isotope work, to have the highest protein turnover

It is clear that if, either from lack of components, or from disuse, the synthetic mechanisms are damaged, the condition must become progressively more difficult to reverse This might explain why such a long time is sometimes needed to restore the malnourished body to normal, not only have the building blocks to be supplied, but the synthetic machinery itself must be rebuilt A possible example of this is the observation of Pieraerts[16] that in the treatment of kwashiorkor with plasma nothing seems to happen until a threshold amount of 600 to 800 ml has been given

Finally, enzyme activity may also be affected by vitamin deficiency since many reactions depend on the presence of a cofactor which contains one or other of the B vitamins The classical example is beriberi, but similar effects have been shown experimentally in other cases - a loss of flavoprotein enzymes in riboflavin deficiency[1] and of transaminase activity in pyridoxine deficiency[19]

RESEARCHES ON ENZYME ACTIVITY IN THE HUMAN LIVER

by

J C Waterlow

The work in recent years of the Gillmans and of the Kampala group has shown very clearly that in kwashiorkor and similar conditions there is structural and functional damage to many organs In the present state of knowledge we cannot say which lesion is most important from the point of view of the body as a whole, nor do we know the sequence of events It may be, as Davies[5] has suggested that liver damage is secondary to pancreatic atrophy and loss of digestive secretions The work described in this paper was done on the liver I do not thereby mean to imply that liver damage must be the primary or fundamental lesion Without prejudging this question, it must always be important to know what is happening in the liver because of its central position in metabolism The results may also throw some light on the reactions of glandular tissue in general Finally, an important reason for studying this organ is the practical one that it is accessible by biopsy

If the structural changes in the liver are the result of malnutrition they must, it would seem obvious, be preceded by a biochemical lesion, in the phraseology of the Gillmans by some 'altered metabolic regulation' That is the very simple idea behind this work, which was begun in Fajara under Professor Platt's inspiration, and has been continued in Jamaica I should like to emphasize, however, that such a biochemical approach by no means supersedes the microscope The histological criterion is still the most sensitive we have for assessing the condition of the liver, since structure changes may be present when functional tests reveal nothing and clinical condition is normal[6 14] The microscope is also essential for delimiting the problem and defining the lesion to be investigated It is clear from work of the last few years that there may be several different forms of liver damage in infants in which deficiency plays at least some part - not only the fatty liver, but also the 'serous hepatosis' described by Hill[9] in Jamaica, and the early fibrosis without fat which we have found in the Gambia[23] No doubt there are also mixed forms We cannot, therefore expect a simple or clear-cut solution in biochemical terms The phrase 'a biochemical lesion' is an over-simplification but it is useful as shorthand

In the search for alterations in cellular metabolism underlying the structural changes it seemed more profitable to attack the dynamic aspects of cellular activity, than simply to measure concentrations or levels of metabolites One way of doing this is by studying enzyme activity - that is the amounts of enzymes in the tissue Broadly speaking there are several ways in which dietary deficiency might affect enzyme activity First, since enzymes are proteins, and since work with isotopes has shown so clearly that all cytoplasmic proteins are in a state of rapid turnover and flux,

These are the objectives of this work, and the speculations underlying it The results so far are meagre, this is partly because there is very little information in the literature about liver enzymes in man, and therefore it is necessary to start at the beginning The most that can be claimed is the demonstration that this method of approach is technically feasible Whether the results will be fruitful, either in a general way, or in application to medicine, I am not yet sure

Material and Methods

I have worked mainly with infants of nine months to two years It has not been possible yet to collect a homogeneous group of cases In the Gambia the clinical picture was usually one of undernutrition and malaria, with few specific signs of deficiency In the liver there was only slight fatty change, with sometimes an early periportal fibrosis In Jamaica, some of the cases were merely undernourished, with the liver histologically normal, others had oedema and fatty liver, in yet others there was the serous hepatosis of Hill[9], with ascites and well marked hepatocellular degeneration It is therefore a mixed bag of patients, partly as a result of circumstances, and partly of intention, since it seemed a good plan at the beginning to cast the net wide I have throughout tried to concentrate on cases in a stage of evolution In all such work it is difficult to establish true normal levels The nearest that I can as yet approach to this is by measurements on infants that have recovered from malnutrition after treatment

The plan was simply to compare the results of enzyme assays and chemical measurements on biopsy tissue taken before and after about one month's feeding on a high milk diet The enzyme assays were done on homogenates by gasometric methods, using the Cartesian diver technique[25] With this tool it is possible to measure the activity of many different enzymes in 1 mg of tissue Measurements of total nucleic acids were made by ultraviolet absorption, and of desoxynucleic acid colorimetrically, using the microscope colorimeter introduced by Holter, and modified by Penney in Platt's laboratory

Before going on to the results, two technical points need to be considered The first is the question of sampling error in the liver The biopsy specimens we get from these infants are not very large, weighing only 5 to 10 mg, of which more than half is taken for histology The remaining 2 mg or so, on which the chemical measurements are done, represents only about 1/200,000th of the weight of the whole liver, and clearly may not be representative We have not felt it justifiable to try and get more than one specimen at any given time, the best, therefore, that I have been able to do to solve this difficulty is to take two separate fragments and make two homogenates Such specimens although coming from points in the liver only a few millimetres apart, do at least represent different lobules The histological findings suggest that the pathological processes with which we are dealing are essentially diffuse Although there is some variation, it is from one lobule to another, rather than from

one large area of the liver to another, as in massive necrosis The results of such comparisons of enzyme activity on duplicate homogenates are shown in tables 1 and 2. With a few exceptions, agreement is satisfactory

Table 1

Human liver biopsies Cholinesterase activity of duplicate homogenates CO_2 output/mg fat-free dry weight/hour

Homogenate 1	Homogenate 2
7 85	7 45
10 6	10 8
7 55	7 7
9 15	9 45
5 55	6 45
9 35	11 85
3 0	4 0
9 2	9 4

Table 2

Human liver biopsies Enzyme activity of duplicate homogenates O_2 uptake or CO_2 output cu mm/mg fat-free dry weight/hour

Name	Enzyme	Homogenate 1	Homogenate 2
Wilson	Cytochrome oxidase	6 1	3 8*
Hunter	Cytochrome oxidase	11 4	10 9
	Cholinesterase	5 5	5 2
Sinclair	Cytochrome oxidase	7 8	7 6
	Cholinesterase	8 4	7 2
	Lactic dehydrogenase	9 9	9 65
Linton	Lactic dehydrogenase	16 7	23 4
Ellis	Lactic dehydrogenase	7 0	6 1

* very fibrous liver

The second difficulty is the basis of representation Conventionally, enzyme activity is expressed per milligram dry weight of tissue In our material dry weight must clearly be corrected for dilution by fat and glycogen, but even when this is done a true picture may not be obtained In animal experiments it is often found that enzyme activity per unit dry weight is not affected by deficiency, but the activity per whole liver, or per whole animal - which is what, presumably, matters - is grossly reduced because of a shrinkage in size of the liver In man we cannot measure the weight of the liver, but theoretically there is a way round this difficulty Experiment shows that the fall in weight of the liver results from a reduction in the amount of cytoplasm per cell, the number of cells and the size and number of nuclei remaining unchanged[11] Balfour[2] gives some examples of this in her paper Therefore in the starved animal 1 mg of liver contains more cells, although smaller ones, and more nuclei, than the normal The best way of expressing the enzyme results would therefore be as activity per cell The number of cells per unit weight of tissue can be estimated either directly, by counting, or indirectly, by measuring the nuclear nucleic acid (DNA), since the amount of this per cell is constant in most tissues[22] I have not so far found a satisfactoiv technique for counting, and therefore turned to DNA as a basis of reference

In the rather small number of cases so far available the figures for DNA content fall within a fairly narrow range, which agrees with that found by others in the human liver[21] It is to be expected that with treatment, as cytoplasm is restored to what Platt has called the 'lean and hungry cell' the DNA content per unit weight should fall Microscopically, one certainly gets the impression that the relative amount of cytoplasm increases as the nutritional condition of the patient improves But the chemical measurements have not shown any consistent trend to confirm this There may be two possible reasons Firstly, the value of DNA as a basis of reference depends upon the assumption that the DNA content per cell is constant This has been shown to be true for a wide range of somatic cells with the diploid number of chromosomes[22] Unfortunately, in the liver there is a high proportion of polyploid cells[8] With treatment and cellular regeneration the degree of polyploidy may increase, causing a rise in DNA content Secondly, it is usual for biochemists to regard the liver as a homogeneous tissue This assumption is probably nearer the truth in the rat than in man Counts I have made show that in the most normal human liver (African), only about two-thirds of the cells are parenchymatous cells, so that the tissue is far from homogeneous Moreover, in our cases, even when there are no gross pathological changes, there is a great tendency to infiltration with lymphocytes, varying from lobule to lobule This would largely destroy the significance of DNA content as a measure of the number of hepatic cells

For these reasons I have not used DNA as a basis of reference but have expressed results per unit weight of protein, as the best compromise This should give a reasonably accurate m of the

active tissue, so long as there is no great dilution with inert protein such as collagen That is probably not a serious danger in early cases without advanced fibrosis

These technical points have been considered in some detail, because they are clearly fundamental if work of this kind is to be begun on a sound basis

Results

Of the vast number of possible enzymes, only a few have so far been investigated These have been chosen partly because of their physiological importance, and partly because they seemed to have a high level of activity, and therefore changes should be more easily detected. As there is almost no information in the literature, the first need is to get some idea of the pattern in man No strictly normal control series is available, and so for the time being I have to use as a temporary standard of comparison the average of all figures obtained in human cases. The results for five enzymes, compared with those found by the same methods in the rat, are shown in table 3

Table 3

Comparison of human and rat liver
O_2 uptake or CO_2 output/mg protein N/hour

	Man	Rat
Cytochrome oxidase	125	950
Lactic dehydrogenase	230	320
Cholinesterase	95	140*
Transaminase	2,350	340
Succinoxidase	15	600ƚ

* female rats
ƚ figure from the literature, by the same method.

Apart from choline esterase, the level of which is affected by nutritional state, the range of variation in the human specimens is not wide, if one or two isolated observations are excluded I think the low cytochrome oxidase and high transaminase in man compared with the rat are real, and far beyond the limits of chance variation or error Rather few observations have so far been made on succinoxidase, and this point is being re-investigated But if these results can provisionally be accepted, the difference in pattern between the two species raises problems of some interest. Succinoxidase belongs to the group of Krebs' cycle enzymes concerned with the

oxidation of pyruvate and of two-carbon fragments derived from the catabolism of carbohydrate, fat and protein This cycle is closely coupled to phosphorylation, and provides most of the chemical energy available for synthetic reactions Transaminases, apart from their importance in the interconversion of amino-acids, can interfere with the Krebs' cycle by removing or adding substrates at three stages - pyruvate, oxalacetate, and α-keto-glutarate These substances are, as Braunstein[4] puts it, at the metabolic crossroads, and may be important links through which the activity of one enzyme system can control or affect the rate of another The great difference in concentration of enzymes in the two species raises the question of whether the normal metabolic paths are the same It re-emphasizes the need for caution in extrapolating from animal experiments to man These results have no immediate application to medicine or nutrition, but are perhaps worth pursuing as a problem in comparative biochemistry

The next point is the effect of malnutrition on the liver enzymes It was found at the outset in the Gambia that in malnourished babies there was a fall in the so-called pseudocholinesterase of the liver roughly parallel with the fall found in the

Table 4

Cholinesterase activity in plasma and liver in undernourished infants (Gambia)

Case No	Age yr	Weight lb	oz	kg	Clinical condition	Biopsy Initial or final	Liver* QCO_2	Plasma† units	Liver fat, percentage of dry weight
232	1 6/12	16	–	7 26	Oedema, died	I	1 0	25 0	34 5
229	1 3/12	12	11	5 76	Oedema, improved	I	2 6	23 2	–
						F	6 2	53 2	5 0
208	2	17	8	7 94	Oedema, recovered	I	4 5	27 8	–
						F	10 3	58 7	15 6
250	1 8/12	13	12	6 24	No oedema	I	5 2	34 5	20 5
						F	7 9	42 9	11 3
235	2	12	10	5 73	No oedema	I	6 9	38 8	17 9
						F	8 4	60 0	12 4
244	3				Splenomegaly, hepatomegaly, active fibrosis No oedema, no improvement	I	3 6	21 2	23 5
						F	4 1	19 9	14 6

* cu mm CO_2/mg dry weight/hour

† cu mm CO_2/ml /minute normal 60-70 units

plasma[24] The reduction was greater in the more severely ill cases, e g. babies with hypoproteinaemia and oedema With dietary treatment there was a rapid rise to normal, except in one case with an active and progressive fibrotic process going on in the liver (table 4) These findings confirm in a general way the hypothesis that this enzyme is synthesized in the liver We cannot tell from these results whether the low enzyme level is caused by damage to the synthetic mechanism, as in cirrhosis[13], or simply by absence of building materials Nevertheless, the finding of low activity in the liver tissue itself is at least

Table 5

ELLIS - F, age 11 months, weight 9 lb 12 oz (4 42 kg)
Liver edge 2 cm below costal margin, soft
No ascites, no oedema

With treatment, rapid weight gain
Liver reduced in size

Histology severe fatty infiltration

	Date of biopsy		
	29 February	21 March	
Serum cholinesterase (Michel units)	0 21	0 50	
Liver cholinesterase (cu mm CO_2/mg protein N/hour)	62	104	(95)
Liver cytochrome oxidase (cu mm O_2/mg protein N/hour)	198	177	(125)
Liver lactic dehydrogenase (cu mm CO_2/mg protein N/hour)	233	307	(227)
Liver transaminase (cu mm CO_2/mg protein N/hour)	2, 500	2, 130	(2, 350)
Fat (as percentage of dry weight)	53. 2	15. 1	(10)
Desoxynucleic acid - DNA - (mg/g of fat-free dry weight)	14. 8	12. 8	(15 7)
Ribonucleic acid - RNA - (mg/g of fat-free dry weight)	10 6	7 3	(10 3)

Figures in brackets are
average values of 22 Jamaican specimens

Table 6

FULLER - *M age 1 yr 9 m, weight 20 lb (9 07 kg)*
Liver edge 6 cm below costal margin (left lobe) Ascites, no oedema

With treatment ascites disappeared and liver reduced in size

Histology 1 *Patchy centrilobular degeneration ? collagenosis*

2 *Regeneration Hyperplasia of kupffer cells Extensive nuclear changes in parenchymatous cells*

	Date of biopsy		
	1 February	28 February	
Serum cholinesterase (Michel units)	0 23	0 61	
Liver cholinesterase (cu mm CO_2/mg protein N/hour)	65	91	(95)
Liver cytochrome oxidase (cu mm O_2/mg protein N/hour)	94	142	(125)
Liver lactic dehydrogenase (cu mm CO_2/mg protein N/hour)	246	269	(227)
Liver transaminase (cu mm CO_2/mg protein N/hour)	1,570	1,970	(2,350)
Fat (as percentage of dry weight)	24 7	8 9	(10)
Desoxynucleic acid - DNA - (mg/g of fat-free dry weight)	15 2	16 7	(15.7)
Ribonucleic acid - RNA - (mg/g of fat-free dry weight)	5 5	10 3	(10 3)

Figures in brackets are average values of 22 Jamaican specimens

positive chemical evidence that the cells are not normal It is unfortunate that we know very little about the physiological function of this enzyme There is experimental evidence that liver esterases can, under certain conditions, form peptide links[12] It seems possible, therefore, that this enzyme might be concerned with protein synthesis In many species it is abund- t in those

tissues where protein synthesis is going on at a high rate - gut, pancreas, liver This, however, is a hypothesis which at the moment is without experimental support

In Jamaica the range of enzymes studied was extended The same reduction in esterase was found, but the other enzymes did not seem to be affected by nutritional state, even in the presence of clear-cut pathological changes in the liver The data from two representative cases are shown in tables 5 and 6 In one of these, as the figures for fat content show, there was severe fatty infiltration In the other there were well marked degenerative changes in the liver cells at the time of first biopsy, and regeneration at the second biopsy These morphological changes are in no way reflected in the figures for enzyme activity, except for cholinesterase

Some figures for cytoplasmic nucleic acid (RNA) are included This has been measured because of the role it is thought to play in protein synthesis They do not show the rise on treatment which is to be expected from animal experiments Furthermore, the ratio RNA DNA is much lower than that found in rats, and lower than the figures so far available for human livers[19] (biopsy specimens) This low level may be real, as it agrees with histochemical observations that there seems to be little stainable RNA Nevertheless, there is danger of losing RNA during extraction when the work has been done in the tropics at high temperatures, this point is being reinvestigated with extra precautions

Conclusion

The negative finding of unchanged enzyme activity is in one way disappointing It was hoped that the biochemical tool would be more sensitive than the microscope So far, however, the reverse is true We could not form any picture of the condition of the liver from the chemical findings alone Nevertheless, it may not be without significance that the one enzyme which is reduced is one for which there is no known physiological role whereas the others, which are well maintained, have important and clearly defined functions Perhaps this is an example of homoeostasis Although we have not yet gained any information about the biochemical lesion or metabolic regulations imposed by the poor diets, this approach may eventually lead to more general knowledge about the physiology of the cell

I should like to express my thanks to Professor B S Platt, under whose wing this work was begun, to Professor K R Hill of the University College of the West Indies for allowing me to use material from his cases to Dr J H Walters and Dr Katerina Rhodes for help with clinical work, and to Dr J P Penney for showing me his technique for measuring nucleic acids

REFERENCES

1 Axelrod, A E & Elvehjem, C A (1941) *J biol Chem*, 140, 725

2 Balfour, B M *This Report, p 120*

3 Bargoni, N (1951) *Experientia*, 7, 104

4 Braunstein, A E (1947) *Advanc Protein Chem* 3, 1

5 Davies, J N P (1948) *Lancet* 1, 317

6 Gillman, J & Gillman, T (1945) *Arch Path (Lab med)* 40, 239

7 Gillman, J & Gillman, T (1951) *Perspectives in Human Malnutrition* Grune & Stratton, New York

8 Harrison, H F (1951) *Nature, Lond*, 168, 248

9 Hill, K R (1951) *Liver Injury Trans 10th Conf Josiah Macy Jr Foundation* New York

10 Knox, W E (1951) *Brit J exp Path* 32, 462

11 Kosterlitz, H W (1944) *Nature, Lond*, 154, 207

12 Lipmann, F & Tuttle, L C (1950) *Biochim biophys Acta* 4, 301

13 McArdle, B (1940) *Quart J Med* 9, 107

14 Meneghello, J (1949) *Desnutricion en el lactante mayor (distrofia policarencial)* Santiago de Chile

15 Miller L L (1948) *J biol Chem* 172, 113

16 Pieraerts, G (1949) *Ann Soc belge Med trop* 29, 231

17 Potter, V R (1949) *Respiratory Enzymes* ed H A Lardy Burgess Co Minneapolis

18 Rosenthal O, Rogers, C S, Vars, H M & Ferguson, C C (1950) *J biol Chem* 185, 669

19 Schlenk, F & Snell, E E (1945) *J biol Chem* 157, 425

20 Schultz, J (1949) *J biol Chem* 178 451

21 Shank, J (1952) *Personal communication*

22 Vendrely, R & Vendrely, C (1949) *Experientia* 5, 327

23 Walters, J H & Waterlow, J C *in preparation*

24 Waterlow, J C (1951) *W I med J* 1, 41

25 Waterlow J C & Borrow A (1949) *C R Lab Carlsberg (Ser chim)* 27, 93

26 Williams, J N, Denton, A E & Elvehjem, C.A (1949) *Proc Soc exp Biol N Y* 72, 386

27 Williams, J N & Elvehjem, C A (1949) *J biol Chem* 181, 559

(1.926)

VARIATION IN BLOOD ENZYMES IN NUTRITIONAL OEDEMA SYNDROME

by

V N Patwardhan

Plasma esterase and lipase were determined in children suffering from nutritional oedema by the methods described by Cherry and Crandall[1], and Goldstein *et al*[2]. The activity of these enzymes was low while the disease was active, it returned to normal on successful treatment. Recent researches[3] seemed to throw some doubt on the presence of lipase in human serum. The identity of the enzyme which was being determined by the method of Goldstein had therefore to be established. A method has been developed which leaves little doubt that the lipolytic action of plasma is due to lipase alone. This depends upon the complete inhibition of esterase action towards tributyrin in the presence of a suitable concentration of sodium tauroglycocholate.

Using the modified technique for plasma lipase and that of Cherry and Crandall for esterase determinations, it has been confirmed that lipase as well as esterase in plasma is depressed in nutritional oedema syndrome. On successful treatment with skimmed milk, the activity of both these enzymes returned to levels obtained in apparently healthy children of comparable age. The findings are summarized in a table in a recent paper[4].

REFERENCES

1 Cherry, I S & Crandall, L A (1932) *Amer J Physiol*, 100, 266

2 Goldstein, N P, Epstein, J H & Roe, J H (1948) *J Lab clin Med* 33, 1047

3 Seligman, A M & Nachlas, M M (1950) *J clin Invest*, 29, 31.

4 Srinivasan, P R & Patwardhan, V N (1952) *Lancet*, ii, 804

Composition of necrogenic diet

	Percentage
Yeast dried, baker's	18 (=7% protein)
Corn starch	73
Salt mixture	3
Olive oil	5
Cod liver oil	1

Supplements of water soluble vitamins thiamine, riboflavin, pyridoxine, calcium pantothenate, were added to the diet

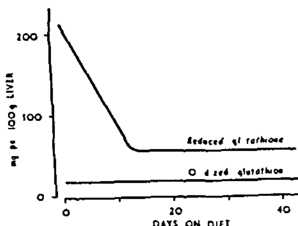


Fig Effect of necrogenic diet on glutathione levels in pre-necrotic livers

one-tenth of its normal value and the ratio between oxidized and reduced glutathione was then 1 1

As tocopherol has a protein sparing effect[1] is an anti-oxidant and prevents dietetic liver necrosis, we thought it might also have an effect on levels and ratios of reduced and oxidized glutathione However, supplementation of the diet with tocopherol, although it prevented the onset of liver necrosis, did not alter the glutathione picture and the animals continued to live in fairly good condition with this subnormal glutathione level

When the necrogenic diet contained more yeast protein or when casein was substituted for yeast, the initial fall in reduced glutathione during the latent period was less marked, but when necrosis eventually developed the reduced glutathione was again found to be one-tenth of its normal value It follows, therefore that the fall in glutathione in pre-necrotic livers is proportional to the degree of deficiency of sulphur-containing amino-acids

Supplementation of the experimental diets with as little as 0 2 per cent of cystine and methionine was sufficient to restore glutathione to its normal level and to prevent liver necrosis

The histological picture of pre-necrotic liver containing a lowered glutathione level showed changes commonly associated with low protein diets Tocopherol supplementation did not change this picture Supplementation of the diet with cystine and methionine

EXPERIMENTS ON DIETARY LIVER INJURY

by

O Lindan and Elizabeth Work

3 LIVER GLUTATHIONE AS AN INDICATOR OF LIVER DAMAGE PRODUCED BY LOW PROTEIN DIETS

The body's requirements of sulphur can be satisfied only by the cystine and methionine contained in the dietary protein These two amino-acids, besides being structural parts of the body proteins are the precursors of all the other main sulphur-containing metabolites (with the exception of sulphur-containing vitamins)

In addition to the specific changes in the relative composition of body proteins[7,13] a deficiency of methionine and cystine is reflected by lowered concentrations of some non-protein sulphur-containing fractions[6], of which glutathione is of special importance[5] This tripeptide forms part of the cell oxidation-reduction system, is involved in the metabolism of the sulphydryl group (-SH) and is believed to be connected with protein synthesis The turnover of glutathione is known to be high Waelsch and Rittenberg[14,15] showed, by the use of isotopes, that glutathione is being constantly broken down and rebuilt in intestine and liver They calculated that half of the liver glutathione is replaced in two to four hours

The present report is on some of the experiments done on the glutathione level in liver damaged by protein deficiency[10,11,12]

Consequent on the work of Himsworth[4] and of György[2,3] an acute liver necrosis can be produced experimentally in rats by prolonged feeding of diets deficient both in sulphur-containing amino-acids and tocopherol ('necrogenic diet') During this Conference György reported that germ-free animals do not behave in the same way (see page 151) As deficiency of cystine and methionine is required for his type of liver damage, the relationship between dietary protein -·iency and liver glutathione levels was investigated during the
17 period before the development of necrosis and also in necrotic
Bi

18 Ros'gure shows diagrammatically the levels of reduced and
J C glutathione in the liver of animals given a necrogenic diet
ion of this diet is shown in the table It contained
19 Schlent protein supplied by baker's yeast which was shown to
in cystine and methionine[9] The diet contained a high
20 Schultz, arbohydrates and it was deficient in tocopherol[8]

21 Shank, J (he reduced glutathione was lowered from 215 mg per
arter of the normal value in 13 days After
22 Vendrely, R & nged for days or weeks until the development
death of the animal We can regard this
23 Walters, J H & Wa lutathione in the pre-necrotic liver as the
e of cystine and methionine deficiency in
24 Waterlow, J C (19 ized glutathione remained unaffected
ding with this low protein diet resul-
xidized to reduced glutathione from
25 Waterlow J C & Bo (1)f 1 3
27, 93
and developed massive liver
26 Williams, J H , De e liver fell further to
exp Biol N Y

27 Williams, J H & Elvehjem, C A (19

(11926)

NITROGEN AND FAT BALANCE IN THE 'NORMAL' ADULTS IN THE BELGIAN CONGO

by

E de Maeyer and J. Close

A preliminary note was presented dealing with the balance of fats and nitrogen in the adult African of Kivu The food intake and the urine and faeces excreted were examined in two cases, for two days in the first, and for four days in the second These experiments were carried out on men aged approximately 20 to 25 years with slight ascariasis - a widespread infestation in the region - but otherwise apparently normally healthy As much food was given as was wanted, but an accurate account was kept of the quantity eaten Vegetables generally used in the region were given, i e beans, cassava, rice, sweet potatoes, and palm oil In addition 125g of meat and ½ litre of skimmed milk were given daily

For the nitrogen balance, the examinations showed

(1) Faecal excretion was high, varying from 2 to 3gN daily Among white persons, the faecal excretion of nitrogen does not normally exceed 10 per cent of the nitrogen taken in In a country such as the USA where there is a high protein intake, the accepted average daily excretion is 1 3g

(2) Considering that the experiments were short - the longest lasting four days - and that the subjects received during the experiment a much richer protein diet than usual, it appeared that the balance became positive and thus that there was retention, when nitrogen intake exceeded some 7g per day

With regard to fats, it is generally admitted that among white persons excretion should not normally exceed five per cent of the fat intake In the experiments it was noticed that this level was nearly always exceeded being in some cases two or three times the accepted maximum It was also found that the quantity of neutral fats excreted represents a high proportion of the total waste fat

To draw a number of provisional conclusions from the two experiments it could be said that

(a) the high quantity of nitrogen passed in the stools seemed to indicate that this element was poorly absorbed
(b) under experimental conditions, a positive nitrogen balance appeared as soon as the intake was in excess of approximately 7g per day
(c) the high content of neutral fats and fatty acids in the stools indicated defective absorption and probably insufficient hydrolysis of the lipids

resulted not only in a normal glutathione content but showed also a normal histological picture In the livers in which there was extensive necrosis there was correspondingly very little glutathione It seems, therefore, that there was a correlation between the liver glutathione level and the histological picture

Conclusion

In conclusion we may say that the amount of reduced glutathione in the liver is dependent upon the composition of the dietary protein and the physiological status of the liver Its estimation, therefore, may serve as an indicator of dietary deficiency and liver damage

Summary

Estimations of glutathione in pre-necrotic and necrotic livers of rats given diets deficient in sulphur-containing amino-acids and tocopherol showed that the glutathione level in the liver may serve as an indicator of protein deficiency and liver function

REFERENCES

1 **Dam, H** *(1944) Proc Soc exp Biol Med* , **55**, *55*

2 **György, P** *(1947) Trans 6th Conf Josiah Macy Jr Foundation, New York, p 71*

3 **György, P & Goldblatt, H J.** *(1939) J exp Med* , **70**, *185*

4 **Himsworth, H. P** *(1950) The Liver and its Diseases, 2nd ed Blackwell Oxford*

5 **Leaf, G & Neuberger, A** *(1947) Biochem J* , **41**, *280*

6 **Lee, W C & Lewis, H B** *(1934) J biol Chem* , **107**, *649*

7 **Lightbody, H D & Lewis, H B** *(1929) J biol Chem* **87**, *485*

8 **Lindan, O & Himsworth, H P** *(1950) Brit J exp Path* , **31**, *651*

9 **Lindan, O & Work, E** *(1951) Biochem J* , **48**, *337*

10 **Lindan, O & Work, E** *(1951) Biochem J* **48**, *344*

11 **Lindan, O & Work, E** *(1951) Ciba Foundation Symp p 47 Churchill, London*

12 **Lindan, O & Work, E** *(1951) Biochem J* **48**, *xxxi*

13 **Smuts, D B , Mitchell, H H & Hamilton, T S** *(1932) J biol Chem* **95**, *283*

14 **Waelsch, H & Rittenberg, D** *(1941) J biol Chem* **139**, *761*

15 **Waelsch, H & Rittenberg, D** *(1942) J biol Chem* **144**, *53*

To overcome these objections, the original apparatus has been altered to one made entirely of glass and ninhydrin has been used to fix the urea Depression of the hydrolysis of urea by ninhydrin had been observed[3] and had been shown to be due to the formation of a ureide As it is now possible to estimate small amounts of α-amino nitrogen with a reasonable degree of accuracy, only 0 2ml of urine need be used for an estimation and the quantity of ninhydrin required to fix the urea is small

The all-glass unit used is shown in the figure

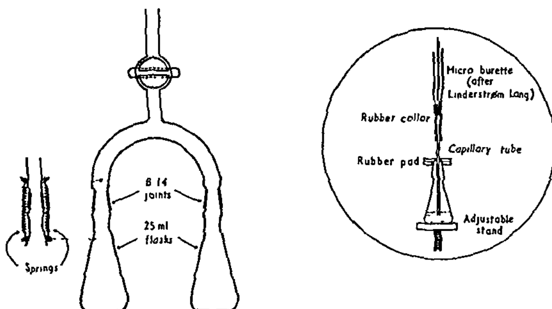


Fig Some features of the apparatus used for the determination of α-amino nitrogen in urine

The necks of the flasks being smooth inside reduces clogging from the dry reagents which are introduced by means of a short-stemmed funnel

A light metal cradle is used for mounting six of these units, and the cradle fits into a water bath which can be heated to boiling by means of an immersion heater

CO_2-free air is required and is conveniently obtained by bubbling air from an aquarium bubbler through ten per cent NaOH into a rubber bladder for storage

Two 'perspex' spoons are needed, one to deliver 100g of ninhydrin and the other to deliver 100g of citric acid - citrate buffer

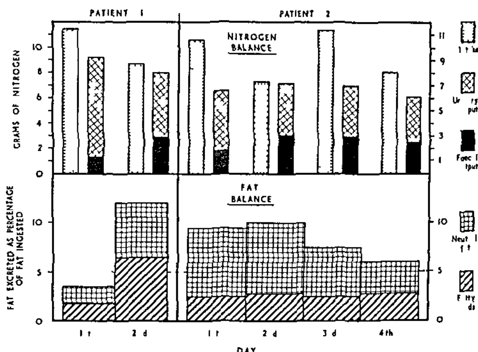


Fig Nitrogen and fat balances of two young African adults (males)

DETERMINATION OF α-AMINO NITROGEN IN URINE

by

B S Platt

In this demonstration a technique is described by which it is possible accurately and speedily to estimate small amounts of amino-acids in blood and urine

The liberation of CO_2 when α-amino-acids react with ninhydrin has been used in a method for the quantitative determination of α-NH_2 nitrogen[4 5] There were two main objections to the method (a) high and variable blanks were obtained due to rubber connections in the apparatus and (b) urea had to be removed from urine by urease Moreover, the presence of canavanine in some urease preparations gave rise to high 'amino nitrogen values' The canavanine can be removed by the method of Archibald and Hamilton[1] but it is a laborious procedure

amounts of ninhydrin may be required to form the ureide, for 0 2 ml urine, however, it may not be necessary to add more than the 100mg specified above The solutions examined are boiled in the reaction vessel as described but care must be taken not to exceed 30 seconds since on prolonged heating urea decomposes and produces CO_2 After boiling, cooling and evacuating, the unit must be kept at 37°C overnight to ensure that the urea is completely fixed

The number of µl of $\frac{N}{7}$ HCl obtained for the difference between the titration for the blank and the sample is equal to the number of µg of α-amino nitrogen in the sample

REFERENCES

1 **Archibald, R M & Hamilton, P B** *(1943) J biol Chem* **150,** *155*

2 **Puddington, I E** *(1943) J Amer chem. Soc* **65,** *990*

3 **Van Slyke, D D & Hamilton, P B** *(1943) J biol Chem* **150,** *471*

4 **Van Slyke, D D, MacFadyen, D A & Hamilton, P B** *(1941) J biol Chem* **141,** *671*

5 **Van Slyke, D D, MacFadyen, D A & Hamilton, P B** *(1943) J biol Chem* **150,** *251*

PAPER CHROMATOGRAPHY OF GAMBIAN URINES AMINO-ACID PATTERN AND EXCRETION OF β-AMINO-ISOBUTYRIC ACID

by

O Lindan

The demonstration included ultra filtration apparatus, de-salter and set-up for chromatography

Examination of the urinary amino-acid pattern by the paper chromatography method revealed that about 25 per cent of 600 Africans examined excreted large amounts of β-amino-iso-butyric acid (BAIBA) Chromatograms of those 25 per cent showed the BAIBA ninhydrin spot to be stronger than that of any other amino-acid An equally high content of urinary BAIBA is known to occur in only 5 per cent of the white population in England[1] A further 15 per cent of the Africans excreted moderate amounts of BAIBA, the strength of BAIBA spot being roughly equal in concentration to that of other amino-acids

Investigations were also carried out in a remote village in the bush where owing to local customs and a lack of outside contacts,

A micro-burette delivering 50µl of acid and a simple device (figure inset) are used during titrations

The *reagents* used are

Citric acid - citrate buffer pH 2 5 (19 15g citric acid
(2 06g trisodium citrate
Ninhydrin
0 12 N (approx) $Ba(OH)_2$ containing 10 5g $BaCl_2$
(to ensure complete precipitation of the carbonate)
1µl $\frac{N}{7}$ HCl (≡ 1µg α-amino N)
Capryl alcohol in a dropping bottle
Phenolphthalein, 0 1 per cent in alcohol
Aluminium stearate lubricant[2]

The necks of six conical flasks are greased with lubricant One or 2 ml $Ba(OH)_2$, diluted according to the amount of NH_2-N in the sample (e g for about 100 µg NH_2-N, 2 ml of 0 012N $Ba(OH)_2$ is required) is pipetted into each flask, which is immediately stoppered The flask may be washed out with CO_2-free air before and after the introduction of the $Ba(OH)_2$, if this precaution is necessary, i e when the amounts of amino-acid are very small Into the reaction vessels, the necks of which are also greased, is pipetted 1 ml aliquot of amino-acid solution or, in the case of urine, 0 2 ml and 0 8 ml water 100mg of buffer and two drops of capryl alcohol are added

The procedure for estimating amino-acid when urea is absent or present in negligible amounts, is as follows

The amino-acid solution is boiled for 30 seconds to remove all pre-formed CO_2 The flasks are stoppered, and cooled by immersion in an ice-cold water bath Ninhydrin (100mg) is added quickly to each cooled reaction flask which is then attached to the U-tube of the unit A baryta-containing flask, after the stopper has been removed, is attached to the other end of the U-tube and the unit is evacuated to 10mm Hg pressure Cooling allows more time for evacuation as the reaction does not commence for about three minutes at temperatures below 10°C

Small springs are attached to hold the flasks in position For ten minutes the unit is immersed to the top of the U-tube in boiling water The flasks containing baryta are then lifted out of the boiling water and placed in ice-cold water and the unit is shaken continuously Distillation occurs and is complete in three minutes

The units are removed and allowed to cool and CO_2-free air is admitted through the vacuum tap The titration vessel can then be removed for estimating the excess $Ba(OH)_2$

When estimations are made on materials containing appreciable amounts of urea some modifications are necessary Additional

URINARY EXCRETION OF AMINO-ACIDS

by

E J Bigwood

The following non-scheduled contribution was presented as additional information in connection with Dr Lindan's observations on urinary amino-acid patterns in Africans and with Professor Platt's paper on nitrogen metabolism in malnourished African children

The fact that urea nitrogen output may be so low and that of the non-urea nitrogen so relatively high in urines from African native infants suggests that the situation may bear some relation to the aminoaciduria described in new-born and prematurely born infants among white populations of Western civilization living in temperate climates This has been investigated in Professor Bigwood's laboratory in collaboration with J P Dustin and S Moore Their findings were presented at the Second International Congress of Biochemistry in Paris in July 1952 The detailed quantitative findings are to be published shortly, the qualitative results are summarized in the table

Urine output in 24 hours of the 18 free α-amino-acids usually found in food proteins and expressed as percentage of total nitrogen (from J P Dustin, S Moore and E J Bigwood)

Percentage	Adult	Infant (born at term) age 25 days	Infant (born at 5½ months) age 38 days
5 to 8		glycine	glycine threonine
1 to 5	histidine lysine serine glycine	histidine lysine serine glutamic acid aspartic acid proline alanine cystine	histidine lysine serine glutamic acid aspartic acid proline alanine cystine methionine isoleucine tyrosine
less than 1	threonine valine methionine isoleucine leucine phenylalanine aspartic acid glutamic acid proline alanine tyrosine arginine	threonine valine methionine isoleucine leucine phenylalanine tyrosine arginine	valine leucine phenylalanine
0	cystine tryptophan	tryptophan	arginine tryptophan
		Percentage	
8 essential amino-acids	2 3	4 5	12 0
10 others	8 1	17 6	23 2
Total	10 4	22 1	25 2

the families tend to be large and there is a certain amount of interbreeding The figure shows the genealogical tree of one of the families and the incidence of BAIBA excretion From this it can be seen that if a high BAIBA excretion is of purely genetic origin then it must be a recessive gene Another interesting point that was noted in this village was the constancy of the general picture of the urinary amino-acid pattern

AMS 2nd WIFE

twins (frat)

AMS 3rd WIFE

● High BAIBA excretion

Fig Genealogical tree of a Gambian family showing the incidence of high excretion of β-amino-iso-butyric acid in the urine

REFERENCE

1 Crumpler, H L , Dent, C E , Harris, H & Westall, R G (1951) *Nature, Lond* , 167, 307

the families tend to be large and there is a certain amount of inter-breeding The figure shows the genealogical tree of one of the families and the incidence of BAIBA excretion From this it can be seen that if a high BAIBA excretion is of purely genetic origin then it must be a recessive gene Another interesting point that was noted in this village was the constancy of the general picture of the urinary amino-acid pattern

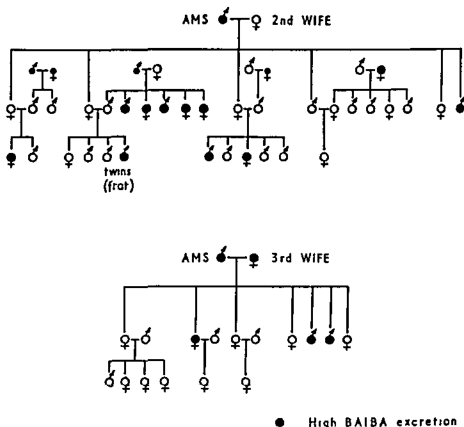


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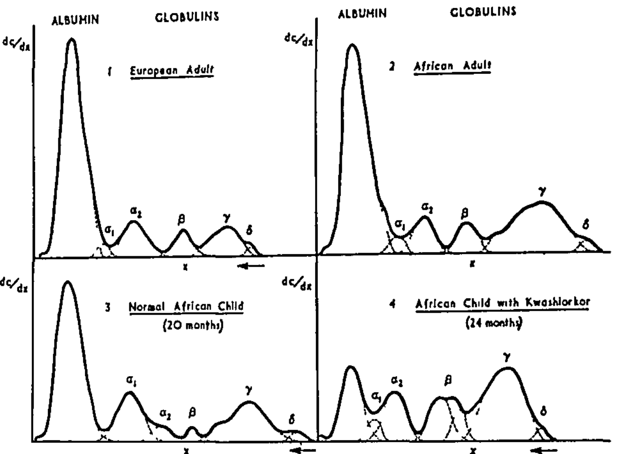


Fig Analysis of blood serum by micro-electrophoresis Amounts of albumin and globulin per 100 ml serum –

Diagram 1 Albumin, 4 24 Globulins $\alpha_1+\alpha_2$ 0 91, β 0 32, γ 0 64, albumin globulin ratio, 2 27
" 2 " 4 17 " $\alpha_1+\alpha_2$ 0 87 β 0 52 γ 2 04 " 1 21
" 3 " 3 86 " $\alpha_1+\alpha_2$ 1 39 β 0 15 γ 1 74 " 1 17
" 4 " 0 91 " $\alpha_1+\alpha_2$ 0 85 β 0 81 γ 1 83 " 0 28

FOUR EXAMPLES OF THE ANALYSIS OF BLOOD SERUM BY MICRO-ELECTROPHORESIS

by

J Close

In the course of a study of proteinaemia in relation to nutrition in the indigenous peoples of the Eastern Belgian Congo, the sera from a number of children with kwashiorkor were examined It was felt that it might be of interest to demonstrate some of our diagrams obtained by the electrophoretic method

Electrophoresis has been selected as the method of analysis since it appears to give the most precise picture of the protein composition of sera, particularly of those from pathological cases

The instrument used for these determinations was Boskamp's apparatus for micro-electrophoresis which was devised by Professor Antweiler of Bonn, this has the several advantages of speed, precision and economy

The four diagrams presented were obtained under the following experimental conditions

quantity of serum used 0 2 - 0 4 c c
barbiturate buffer pH 8 62
ionic strength 0 12
dialysis for 1½ hours at room temperature
duration of electrophoresis 18 minutes with a current of about 1 8mA at 70 to 75V
temperature of the cell $10^{0}C$

The curve for *dc/dx* as a function of *x* was made by means of a Jamin interferometer, set up on a mobile table which allowed a study of the gradient for the index of refraction at each part of the electrophoresis cell A preliminary calibration made possible the quantitative evaluation of each of the fractions

Two points are seen at once from an examination of the first two diagrams firstly that with a similar quantity of albumin the albumin globulin ratios were very different - 2 27 for the European and 1 21 for the African and secondly, the special importance of the γ-globulin fraction in the serum of the African This high value alone almost explains the difference in the albumin globulin ratios As is well known, this high value for the globulins also explains the positive reactions of the majority of Congo Africans to different 'liver tests'

had higher γ-globulin levels than the average European Only after treatment had been continued for at least three months was it possible to obtain a reduction of γ-globulins In view of these results, attention was drawn to the susceptibility of the African to infectious diseases

Other illustrations were demonstrated showing the well-known specific effect of parasites on certain globulin fractions

A typical diagram of the results of electrophoresis of the plasma of a child from a village in the neighbourhood was given (see figure) This example was from a systematic study being made in collaboration with Medecin-Capitaine Andre (paediatrician at the General Hospital, Brazzaville) of the plasma proteins of negro infants The child, who was three years old and weighed 11 95kg (26 3 lb), showed definite clinical anaemia, wrinkled and pigmented conjunctivae, a small liver and a greatly enlarged spleen The haemoglobin was 70 per cent and the red blood cell count was 3,000,000 per cu mm Ankylostome and Giardia infections were present and schizonts of *Plasmodium falciparum* were found The urine showed no sugar or albumin and there was nothing abnormal in the sediment, the urinary urea was 12g per litre The total plasma protein was 8 1g per 100ml , distributed as follows albumin 3 9, α-globulins 1 3, β-globulins 0 7, γ-globulins 2 2; the total albumin and globulins were 8 0 and the albumin globulin ratio was 0 96 This electrophoretic pattern is identical with that of numerous African children who appear generally healthy but who harbour malarial and intestinal parasites In the course of an enquiry made by L Lamy and H Lamy at the Institut Pasteur, Brazzaville, it was found that 56 5 per cent of all the children studied had ankylostome infections and 46 3 per cent had malaria *(P vivax* and *P falciparum)*

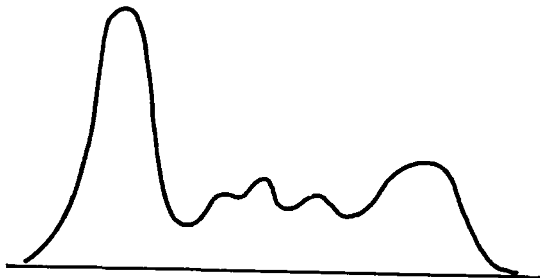


Fig Result of electrophoresis of the plasma of a three year old child from a West African village

The two other diagrams make it possible to compare the serum protein levels in a normal African child and in one with kwashiorkor The value for the total globulins was about 3 28g for the normal child and 3 49g for the child with kwashiorkor, the level of albumin in the child with the malnutritional syndrome was less than a quarter of that of the healthy child This observation makes clear in a very definite way the effect of nutrition on the quantity of albumin It is equally clear that the β-globulins are of importance, probably in the form of lipoproteins

It should be made clear, however, that in several other cases of kwashiorkor this method has revealed an increase in the α-globulins No conclusion can yet be drawn from these observations Even though similar results have been obtained before, using chemical methods of fractionation, these electrophoretic diagrams are presented as they show the results strikingly

A CONTRIBUTION TO THE STUDY OF PLASMA PROTEINS IN THE AFRICAN

by

M J Ganzin

Some results were presented of the separation by electrophoresis of proteins of the sera of Africans The apparatus of Macheboeuf and Rebeyrotte[4], which is a modification of that of Durrum[1], was used A full account with photographs has already been published[3]

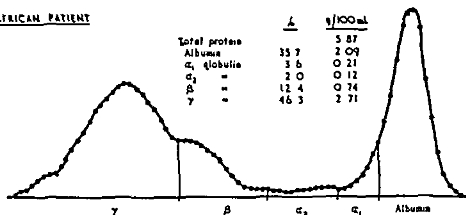
Examinations of the sera of patients with trypanosomiasis gave results essentially identical with those obtained in Africans with other parasitic infections i e reduction in or reversal of the albumin globulin ratio In the blood-lymph stage there was a considerable rise in γ-globulin which tended to fall when the nervous system became involved

By contrast, the average γ-globulin content of blood taken from 68 Africans who had been treated for three months with antimalarials followed by the removal of intestinal parasites who had been X-rayed and who had been found to have negative Wassermann reactions and normal blood counts was less than that of both Europeans and 'apparently healthy' Africans

Parasitization produced a transitory and reversible rise in antibodies (a report of this work is being prepared for publication), whilst in the European the effect of vaccination was retained in the γ-globulin fraction and gave a persisting immunity On the other hand, in the African whose general condition was satisfactory either intestinal or malarial parasites were almost always found if investigations were sufficiently extensive (e g rectoscopy) these subjects

a chemical method for estimating γ-globulin (precipitation with saline ammonium sulphate) also gives high figures for African sera, but the values are not as high as those obtained by electrophoresis Some fraction of the sera, therefore, has the electrophoretic mobility of γ-globulin but is soluble in saline ammonium sulphate

The significance of the raised γ-globulin levels is now under investigation It is possible that it is a symptom of the mild liver damage commonly seen in Africans, which may be the result of a protein deficient diet in infancy



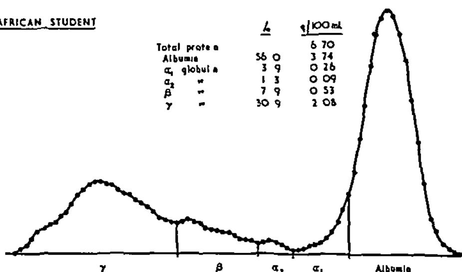


Fig Plots of readings (Antweiler electrophoresis apparatus) on sera of an apparently healthy male medical student and an African patient suffering from malnutrition

REFERENCE

1 Cabib, E (1952) *Biochim biophys Acta* 8 607

The diagram in the figure was obtained by electrophoresis on Whatman No 2 filter paper 32 x 5 cm, with a current of 0 5mA per cm at 300 volts for 8 hours, a buffer pH of 8 6 and a $\Gamma/2$ of 0 15, after electrophoresis it was dyed with bromophenol blue and acetic acid[2] The reduction in the albumin globulin ratio is classic and the preponderance of α-globulins over β-globulins is also usual in negro children with malaria We have found, though infrequently, very low amounts of α-globulin in some children It is undoubtedly relevant that there is a period of allergy supervening on the onset of the infestation or primary infection

REFERENCES

1 Durrum, E L *(1950) J Amer chem Soc* , 72, 2943

2 Durrum, E L , Paul, M H & Smith, E R B 1952) *Science*, 116, 428

3 Ganzin, M , Rebeyrotte, P , Macheboeuf, M & Montezin, G (1952) *Bull Soc Pat exot* 45, 518

4 Macheboeuf, M , Rebeyrotte, P & Bruneric, M (1951) *Bull Soc Chim biol Paris* 33, 1543

PAPER CHROMATOGRAPHY AND ELECTROPHORESIS OF SERUM PROTEINS OF MALNOURISHED AND NORMAL SUBJECTS

by

Margaret W Stanier

PAPER CHROMATOGRAPHY

An example of a simple method[1] was presented

ELECTROPHORESIS

The two diagrams here presented show the ascending boundary patterns obtained by micro-electrophoretic separation (Antweiler method) of the sera of (a) an apparently healthy adult African male medical student and (b) an African patient suffering from malnutrition

It will be seen that compared with normal European sera the γ-globulin area is large in the healthy African, and even larger in the patient The finding of a raised γ-globulin level in apparently normal African subjects is extremely common It is interesting that

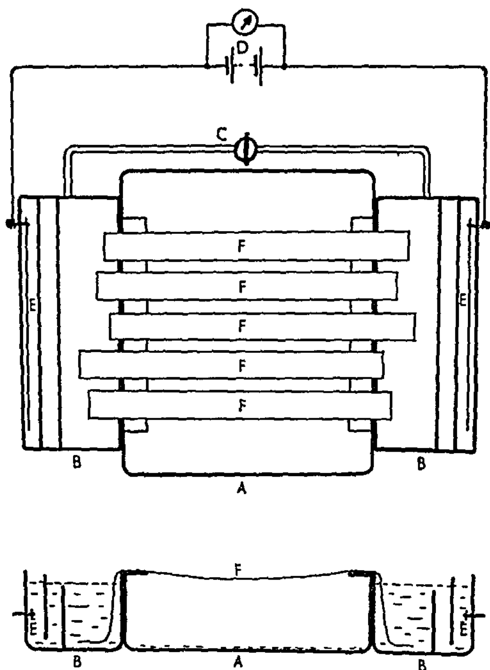


Fig 1 A enamel or plastic tank containing a film of water
B,B plastic tanks (each with two perspex sheets sealed to ends and one to the bottom) containing barbiturate buffer at pH 8 6
C tube with glass tap connecting buffer tanks
D 70 V battery and milli-ammeter in series
E E platinum electrodes
F F paper strips

SEPARATION OF PLASMA PROTEINS BY PAPER ELECTROPHORESIS

by

P R Payne, B S Platt and D F White

Several types of apparatus for the preparation of a mixture of proteins into its constituents by the method of electrophoresis on filter paper have been described[1 2,3]

The apparatus shown is of extremely simple construction, using readily available materials and may be employed for the separation of either single samples or up to ten samples simultaneously

In order to conserve buffer solution and avoid changes of pH on the filter paper strips during a run, it is necessary to confine the products of electrolysis to the vicinity of the electrodes and prevent them from changing the pH of the buffer immediately surrounding the ends of the paper strips as much as possible

To achieve this, a labyrinth is made in the perspex electrode vessels by means of two partitions in each One partition extends above the level of the buffer but has a small clearance (ca 1mm) between its base and the base of the electrode vessel, while the other is fixed to the base of the electrode vessel but does not extend quite as high as the level of the buffer The electrodes themselves consist of 0 001 inch thick platinum strip

The filter paper employed is Whatman No 1 cut into strips 3 cm x 40 cm About 0 01 ml of protein solution (containing 0 2 - 2 mg of protein) is applied in a line across the strip by means of a 0 02 ml blood pipette with the end ground flat, and the strip is then sprayed very evenly with buffer solution

The strips are suspended across the dish with their ends protruding into the buffer solution in the electrode vessels, and the dish is covered with a glass plate A steady potential of 140 volts is applied to the electrodes, by means of a stabilized power supply, for a period of 16 to 24 hours

The strips are then removed, dried in an oven at 100°C and stained The staining solution consists of a saturated solution of Naphthalene Black 12B 200 in methanol containing 10 per cent acetic acid After ten minutes in the staining bath the strips are washed in 10 per cent acetic acid kept gently stirred, until the areas containing no protein are uniformly white two or three successive washings in fresh solution are sufficient Some workers use 10 per cent acetic acid in methanol for washing, but the present method has been found perfectly satisfactory and obviates the necessity of recovering the washing solutions

Direct photometry is used in the present apparatus The disadvantages enumerated above have been avoided by the use of a drying, transparent varnish, having the same refractive index as the material of the paper, to render the strips transparent (figure 2)

The strips are soaked in the varnish, allowed to dry and the process then repeated To ensure rapid penetration of the pores of the paper and a complete absence of air-pockets it is advantageous to perform this operation under a slight vacuum This treatment renders the strips very clear and uniformly transparent, giving them a smooth, glossy surface, as well as considerable strength and durability

In the 'scanner', light from a 36 watt bulb is focused on to a slit, passes through the filter strip and on to a barrier layer photoelectric cell A compensating cell, with its output connected in opposition to that from the measuring cell, serves to balance out the blank due to the residual opacity of the filter paper strip The resultant output is measured on a high sensitivity, low resistance microammeter

The strip is gripped between two rollers, with knurled edges, connected to a slow motion reduction drive such that one turn of the driving knob moves the paper forward 1 mm Two easily exchangeable slits are provided one of 1 mm width for maximum resolution, and one of 2 mm width for greater light sensitivity

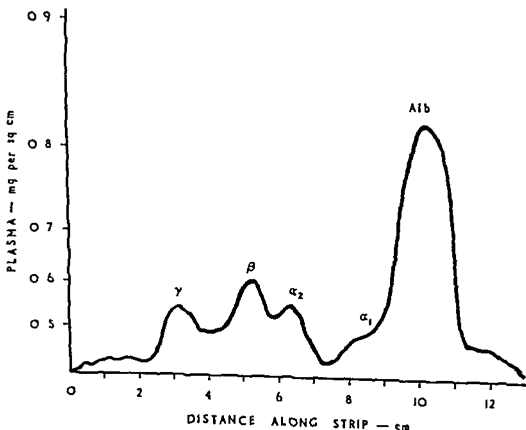


Fig 3 Electrophoretic analysis of normal human serum

Estimation

Two methods have been used for the estimation of the variations of the protein concentration along the filter paper strip

The first method is that of dye elution[1,3] in which the stained area is cut into sections about 5 mm wide, the dye is eluted from each section separately and the quantity of eluted dye is estimated in a standard colorimeter Since the protein on the strip may extend for a length of 10 to 15 cm, 20 to 30 separate elutions and estimations must be made, making the method rather tedious Also, to obtain a sufficient amount of protein for each estimation, the strips may not be cut into sections much less than 5 mm wide, so that only 20 to 30 points are available to plot a curve of protein concentration against distance In many physiological fluids (such as plasma and milk) there may be six or more protein components after electrophoresis, and the limited number of plotted points available will lead to poor resolution and, in practice, some incompletely separated components may be masked altogether

The second method is that of direct photometry of the protein on the strip[2] In this method the filter paper is rendered transparent by soaking it in a liquid with the same refractive index as the material of the paper itself, and then mounted between glass plates The difficulties with this method have been that the paper becomes very fragile when wet, that it is difficult in practice to eliminate all air bubbles in mounting the wet strip between the glass plates, and that it is necessary to provide an accurately positioned mount and drive for the mounted strip

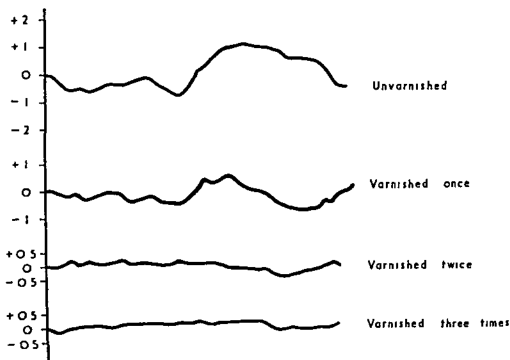


Fig 2 Reduction of variations in the optical density of filter paper by vacuum impregnation with clear varnish

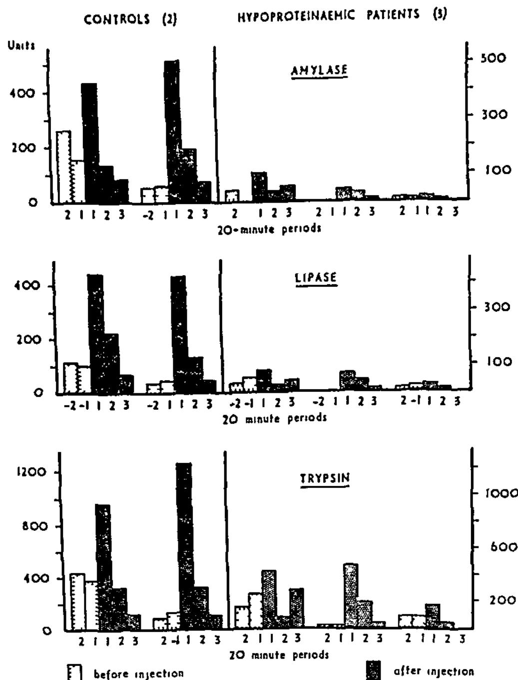


Fig 1 Pancreatic enzymes in duodenal contents of adults in 20-minute periods before and after stimulation with intravenous injection of secretin (0 5 mg per kg body weight) and pancreozymin (1 0 mg per kg body weight)

2 surgical patients (controls)
Serum proteins per 100 ml serum -

Total	6 8 g and 6 8 g
Albumin	2 9 g and 3 1 g

3 hypoproteinaemic patients
Serum proteins per 100 ml serum

Total	5 8 g, 4 9 g and 3 7 g
Albumin	2 1 g 1 8 g and 0 8 g

In this way the strip may be scanned 1 mm at a time, each observation takes only a few seconds, and 100 to 150 points are provided for plotting the concentration curve An entire strip may be scanned and plotted in about 20 minutes

The method is sufficiently sensitive to detect with certainty a protein concentration of about 0 01 mg protein per sq cm on the paper

An example of an analysis of 'normal' human serum is shown in figure 3.

REFERENCES

1 **Flynn, F V & De Mayo, P** *(1951) Lancet*, **ii**, *235*

2 **Grassmann, W , Hannig, K & Knedel, M** *(1951) Dtsch med Wschr* , **76**, *333*

3 **Kunkel, H G & Tiselius, A** *(1951) J gen Physiol* , **35**, *89*

PANCREATIC FUNCTION IN A TYPE OF KWASHIORKOR (KAMPALA AREA)

by

Margaret D Thompson

The activity of pancreatic enzymes, amylase, lipase and trypsin, has been measured in duodenal contents obtained by intubation under radiological control The concentration of enzyme activity in resting juice was very low in children admitted with kwashiorkor compared with that in control children in the same age group[5] It is probable that this represents a failure of enzyme production rather than a lack of stimulus Although it has not been possible to test the effect of secretin and pancreozymin in children, these stimulants were without effect in three adults showing signs of kwashiorkor and depression of pancreatic enzymes (figure 1) The histological changes in the pancreas at autopsy and recorded by Davies[3] were also present in our fatal cases and suggest an interference with secretory function as there is very little cytoplasm left in the acinar cells

Children recovering from kwashiorkor after treatment with high protein diets showed recovery of pancreatic enzyme concentration to levels comparable with those of the controls[5]

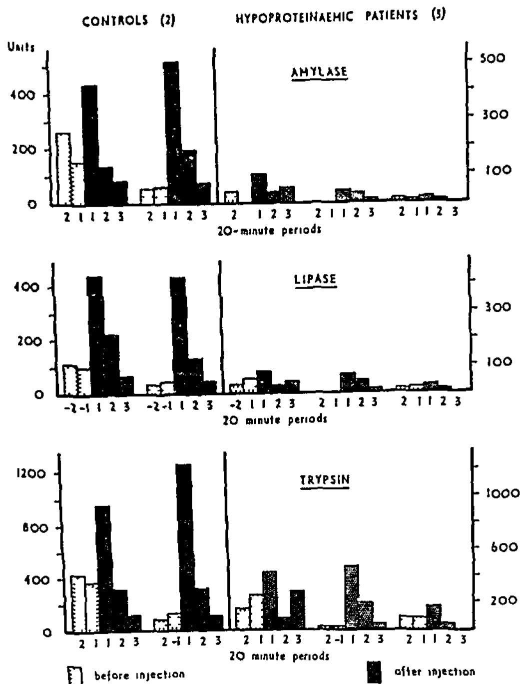


Fig I Pancreatic enzymes in duodenal contents of adults in 20-minute periods before and after stimulation with intravenous injection of secretin (0 5 mg per kg body weight) and pancreozymin (1 0 mg per kg body weight)

2 surgical patients (controls)
Serum proteins per 100 ml serum -
Total 6 8 g and 6 8 g
Albumin 2 9 g and 3 1 g

3 hypoproteinaemic patients
Serum proteins per 100 ml serum
Total 5 8 g, 4 8 g and 3 7 g
Albumin 2 1 g 1 8 g and 0 8 g

The effects of different levels and types of protein were investigated (figure 2) Large amounts of either milk or soya protein were effective but they were not strictly compared weight for weight With lower protein intakes, recovery may occur on 20g milk protein daily Diets containing less than 20g vegetable protein (maize and wheat) were not effective Soya has not yet been tested at lower levels

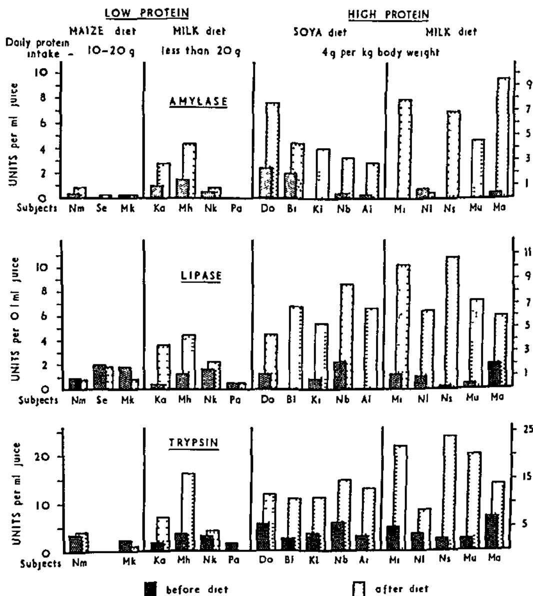


Fig 2 Concentration of pancreatic enzymes in resting duodenal contents of children with kwashiorkor fed on different diets

ENZYME METHODS

Amylase was measured in units calculated from the reaction constant, starch being used as substrate[1]

Lipase was measured by titration of fatty acid liberated by duodenal contents from olive oil with bile as activator[4]

Substrate	Olive oil 1 0 ml warmed and allowed to cool
Buffer	5 ml phosphate buffer pH 8 0 (50 ml M/5 KH_2PO_4) (45 2 ml M/5 NaOH) diluted to 200 ml
Bile	0 1 ml 25 per cent bile salt solution
Juice	0 1 ml
Procedure	Shake in stoppered flask at 37°C for 30 minutes Add 15 drops of concentrated HCl and remove flask from water bath Add 20 ml benzene and shake for 30 minutes Allow to stand (preferably overnight) until layers have separated Remove 10 ml aliquot from benzene layer and titrate with N/20 alcoholic NaOH, using thymol blue as indicator
Calculation	$\frac{a \times 2}{2}$ = units of lipase per 0 1 ml juice in ml N/10 NaOH, where 'a' is titration figure in ml N/20 NaOH

Trypsin was measured by the colorimetric estimation of the digestion products of a sulphanilamide-azocasein or azo-albumin complex[2,6]

Trypsin concentration in resting duodenal contents of Uganda children (units per c c)

	Controls (6)		Kwashiorkor cases (10)			
No	Age (months)	Concentration	No	Age (months)	Concentration on admission	Concentration on discharge
27	24	24	41	24	3 5	19 5
28	12	17	42	18	1 5	22 5
29	15	45	43	21	3 0	9 5
30	36	15	44	36	3 5	22 5
31	42	13	45	30	7 0	14
32	18	6 5	46	15	3 5	8 5
			47a	18	2 5	20
			47b	18	5 0	22
			48	18	5 0	22 5
			49	18	2 5	24
	Mean	20 1		Mean	3 7	18 5

REFERENCES

1 Agren, G & Lagerlöf, H (1936) *Acta med scand*, 90, 1

2 Charney, J & Tomarelli, R M (1947) *J biol Chem* 171, 501

3 Davies, J N P (1948) *Lancet*, 1, 317

4 Frazer, A C, Sammons, H G & Thompson, M D (1952) (in press)

5 Thompson, M D & Trowell, H C (1952) *Lancet* 1, 1031

6 Tomarelli, R M, Charney, J & Harding, M L (1949) *J Lab clin Med* 34, 428

THE USE OF CHROMIC OXIDE (Cr_2O_3) FOR THE DETERMINATION OF THE DIGESTIBILITY AND ABSORPTION OF FOODS

by

Hilary M Dewey and B S Platt

It has been customary to determine the digestibility of foods and the absorption of nutrients by the same procedures as are used in 'balance studies' These include careful collection of urine and faeces for several days complete measurement of foods eaten and the administration of a substance, e g. carmine, to mark the faeces at the beginning and at the end of the test period The 'balance' procedure is not altogether satisfactory because 'marking' of the faeces is often imprecise If, however data on digestibility and absorption alone are required, some less tedious method is desirable

Chromic oxide (Cr_2O_3), sometimes known as 'green tea', has been used as an indicator in digestibility trials in ruminants, it has been applied to human subjects in an investigation by Kreula[5] of the absorption of carotene and he affirms that no harm was done to the health of the subjects to whom the oxide was administered Chromic oxide is so insoluble and inert that it seems unlikely that it could be harmful, which was a possible objection mentioned by Schneider[6] though he informs us that he knows of no data to support this view Irwin and Crampton[3] found that recovery of ingested chromic oxide from the faeces was substantially complete They investigated three methods of administering the indicator (a) in single daily doses, (b) in three equal doses during the day and (c) by feeding at each meal 0 25g chromic oxide per 100g of dry food The results found by this 'indicator method' for apparent digestibility of food were similar to those obtained by the conventional balance techniques In adult human subjects, mixing in the alimentary canal was so uniform that sampling could be begun at the second defecation after oxide

had been given A composite sample from portions of the second and fifth defecations was used for analysis though the results for each portion separately were similar

Hitherto, the chromium in faeces had been determined as dichromate by a macro method A micro method for determining the chromium is now described Only small samples are needed for analysis Iron is separated at one stage in the procedure and other minerals giving the colour reaction are likely to be present in amounts relatively so small as not to interfere with the determination of chromium Furthermore, the introduction of a micro method makes it possible to administer smaller quantities of chromic oxide than those employed by other investigators

METHODS

Administration of chromic oxide In trials made in the Gambia (some results of the application of these methods are reported on page 163) the indicator substance was always intimately mixed with the food It was found that a complete mixing of the indicator with faeces was only achieved on the third or fourth day after continuous administration of 'marked' food The alternative procedures of giving single daily doses or divided doses, as investigated by Irwin and Crampton[3] were therefore not used, as even greater delay in mixing in the alimentary canal might be expected It should, however, be noted that the subjects of the Canadian investigators were normal - our trials were made on infants and young children, some of whom had disorders of function of the alimentary canal

The main purpose of the investigations was to determine the digestibility of proteins fed in different amounts The diet used was compounded from rice, sugar and skimmed milk powder The rice was washed, dried and ground into a powder in a hand-mill and then thoroughly mixed with chromic oxide by shaking in a large screw-topped jar The dry green mixture was cooked as a porridge, suitable amounts were boiled for half-an-hour in salted water and weighed amounts were fed in three meals during the day The final concentration of chromic oxide in the dry diet was 0 22 to 0 33 per cent

Preparation of food and faeces for analysis Faeces were collected for 24 hours when, usually on the third or fourth day, they became uniformly green in colour All analyses were made on dry food and faeces The faeces, if not already acid, were acidified with concentrated sulphuric acid and dried by leaving overnight in a vacuum in a desiccator When dried they were ground into a fine powder

ANALYTICAL METHODS

For nitrogen the microKjeldahl method as described by Kabat and Meyer[4] was used

REFERENCES

1 Agren, G & Lagerlöf, H (1936) *Acta med scand* 90, 1

2 Charney, J & Tomarelli, R M (1947) *J biol Chem*, 171, 501

3 Davies, J N P (1948) *Lancet*, 1, 317

4 Frazer, A C, Sammons, H G & Thompson, M D (1952) (in press)

5 Thompson, M D & Trowell, H C (1952) *Lancet*, 1, 1031

6 Tomarelli, R M, Charney, J & Harding, M L (1949) *J Lab clin Med*, 34, 428

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Hilary M Dewey and B S Platt

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Chromic oxide (Cr_2O_3) sometimes known as 'green tea', has been used as an indicator in digestibility trials in ruminants, it has been applied to human subjects in an investigation by Kreula[5] of the absorption of carotene and he affirms that no harm was done to the health of the subjects to whom the oxide was administered Chromic oxide is so insoluble and inert that it seems unlikely that it could be harmful, which was a possible objection mentioned by Schneider[6] though he informs us that he knows of no data to support this view Irwin and Crampton[3] found that recovery of ingested chromic oxide from the faeces was substantially complete They investigated three methods of administering the indicator (a) in single daily doses, (b) in three equal doses during the day, and (c) by feeding at each meal 0 25g chromic oxide per 100g of dry food The results found by this 'indicator method' for apparent digestibility of food were similar to those obtained by the conventional balance techniques In adult human subjects, mixing in the alimentary canal was so uniform that sampling could be begun at the second defecation after oxide

REFERENCES

1 Cahnmann, H J & Bisen, R (1952) Analyt Chem, 24, 1341

2 Dingwall, A, Croson, R G & Beans, H T (1934) Amer J Cancer, 21, 606

3 Irwin, M I & Crampton, E W (1951) J Nutr, 43, 77

4 Kabat, E A & Mayer, M H (1948) Experimental Immunochemistry Thomas, Springfield, Ill

5 Kreula, M S (1947) Biochem J, 41, 261

6 Schneider, B H (1935) J biol Chem 109, 249

A CHANGE OF HAIR PIGMENT OF MALNOURISHED CHILDREN REVEALED BY PAPER CHROMATOGRAPHY

by

J Nagchaudhuri and B S Platt

Alteration in the colour of the hair is recognized as one of the features of certain types of malnutrition and is accepted as a characteristic of the kwashiorkor syndrome Hitherto no report has been made on the nature of the change of the hair pigment

The demonstration shows by paper chromatography that the pigment from the 'red' or tan-coloured hair of malnourished Gambian children behaves differently from the pigment of normal black hair of the African or Indian subject, or the 'red' (auburn or ginger) hair of the European or the black hair of the hooded rat but in a similar manner to those extracted from hairs oxidized with hydrogen peroxide or exposed to ultraviolet light Pigment with behaviour like that of red Gambian hair could be obtained from the hair of hooded rats on a low protein diet (7 per cent casein) or on a methionine deficient diet (7 per cent arachin), or on a high protein diet (16 per cent casein) when the animals on this last diet were exposed a long time to ultraviolet light

The method used to obtain pigment was as follows

Hairs were washed with alcohol and ether several times and dried to remove grease and 0 2 to 0 3g of each sample of dried hair was introduced into Pyrex ampoules 15cm long and 1cm internal diameter

The pigment was extracted by a modification of Arnow's method1 Two to 3ml of 0 1 NHCl was added to each sample and

Micro-determination of chromium in faeces The chromium is oxidized to chromate with an alkaline fusion mixture and forms a magenta-coloured compound with diphenyl carbazide which is estimated photometrically

Reagents Potassium dichromate AR. Stock solution 0 5656g per litre
Working standard dilute x 100, 1 ml = 2μg Cr

Fusion mixture* 25g sodium carbonate AR
1g potassium chlorate AR

Sulphuric acid AR 25 per cent

s diphenyl carbazide 0 25 per cent in 95 per cent ethyl alcohol, freshly made each time†

Dry ashing and fusion Twenty to 40mg dried faeces are weighed in platinum crucibles and dry ashed with lids on in a muffle furnace at 525 to 540°C for 40 minutes The ash should be greyish-green or yellowish with no black spots of carbon If this temperature range is exceeded the ash may sinter and losses occur About 200mg of the fusion mixture is added and the ash fused over a low flame, whilst the crucible is gently swirled, and heated to red heat for about two minutes

The platinum crucible when cool is placed in a beaker, distilled water is added and the beaker heated to disintegrate the salt cake The crucible is washed well with warm distilled water and the solution filtered from ferric oxide and other insoluble residues The filtrate is made up to 250ml

Into each glass-stoppered tube, marked at the '10ml level', 1 5ml of the filtrate is poured Half a millilitre of 25 per cent sulphuric acid is added to bring the pH to 1 5 to 1 8 Distilled water is added to bring the volume up to about 9ml , then 0 5ml of the diphenyl carbazide reagent is added and the volume is made up to the mark with distilled water The tubes are shaken very well and the optical density read at 543mμ against a reagent blank in cuvettes of 1cm diameter 5 to 15 minutes after adding the reagent

Sensitivity 0 005μg Cr/ml final solution
2μg Cr give an optical density of 0 09
The solution follows Beer's law up to 10μg Cr

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* We have used the mixture recommended by Dingwall Crosen and Beans[2] however Cahnmann and Bisen[1] state that this mixture attacks the platinum crucible considerably and they recommend a mixture of sodium and potassium carbonate in molecular proportions which has a lower fusion temperature 200mg carbonate mixture and 20mg potassium chlorate are added to the ash residue

† If 4 per cent phthalic anhydride AR is added the solution will keep for a month in the refrigerator The solid reagent should also be kept in the refrigerator

DISCUSSION

Professor JACQUOT said he would like to make three comments on the conclusions in the paper by Dr Dean (see page 78). In making these comments he was quoting figures from memory but although these might not be precise, they were certainly of the right order

Referring to Dr Dean's suggestion that methionine deficiency might be the cause of kwashiorkor, he drew attention to the need for considering the relative amino-acid requirements of a young growing organism and of adults in equilibrium From the results of the work of Mitchell, Albanese and others, the following ratios for lysine and methionine could be obtained. taking tryptophan as the unit, the ratio of lysine to tryptophan during growth is 5 and in the adult 2, for methionine to tryptophan the values are 2 during growth and 4 in the adult, the ratio of lysine to methionine is therefore 5.2 during growth and 2 4 in equilibrium In other words, a great deal of lysine and little methionine are required for growth, while in a state of equilibrium there is need for little lysine and more methionine Considering this, it is difficult to see why, if methionine deficiency is the cause of kwashiorkor, this illness attacks children particularly, when it might rather be expected to affect adults

He drew attention to the fact that analytical data for amino-acids showed that the amount of methionine is the same in the proteins of both milk and maize, yet kwashiorkor occurs on a maize diet and is cured by milk. In fact, this identity of methionine levels is correct only if calculated on a protein basis, not when related to the actual diet Besides this, the actual amount of a given amino-acid is not, in itself, of significance There may be a considerable discrepancy between the level of an amino-acid and its metabolic value Efficiency of amino-acids is not only a function of the actual quantity present in the diet but also depends on an equilibrium with other amino-acids There is a synergism between all indispensable amino-acids Therefore the efficiency of a given amino-acid (such as methionine) depends on the degree of balance of all amino-acids In this sense there is a great difference between the proteins of milk and maize The chemical method of Block and Mitchell[1] makes possible a classification of proteins according to the percentage deficiency of a limiting factor This method makes possible the recognition of deviations from a standard the greater the deviation, the lower the value of the protein The following values are relative to milk and maize proteins and to an imaginary protein, 'X', completely deficient in one essential amino-acid

	Milk	Maize	'X'
Methionine	3	3	3
Deviation from standard	10	70	100
Biological value	95	30	0
Digestibility	95	80	

the ampoule was sealed off and heated for 18 hours in an oven at 120°C The extract was then collected in a centrifuge tube and spun for a few minutes The supernatant liquid was filtered through a sintered glass funnel and 20µl of the filtrate was transferred to strips (12" x 1" - 30 5cm x 2 5cm) of Whatman No 4 paper The spots were dried The strips of paper were then developed for 25 minutes in a tank with a solvent consisting of equal parts by volume of redistilled ethylene, chlorohydrin and 0 2N acetic acid The strips of paper were taken out and air-dried The pigment obtained from normal black hair did not move on paper whereas that from the red hair of the malnourished Gambian child moved (see plate 52)

REFERENCE

1 Arnow, L E , *(1938) Biochem J* 32, 1281

of the kind offered by Professor Brock. Further, two papers on the changes which occurred as a result of malaria in well-nourished Americans described a slightly different pattern, there was a fall in serum albumin and a rise in α-, β- and γ-globulins, though the latter was very slight The conclusion could be drawn, however, that there was continued liver dysfunction, and that was also the conclusion reached by workers in the Belgian Congo These workers had also shown that at birth the mean diameter of the red blood cell of African babies was equal to that found in Europeans but that later in life, with the change in the serum proteins, the mean diameter of the red blood cells increased and their number fell

Dr WATERLOW agreed with Professor Holmes's description of the tissues as being like a jelly-fish Without actually having done balances, he had obtained the same impression from clinical observations on children, namely, greatly improved health without any increase in weight Referring to Dr Lindan's observations about water-logging in rats, he said that, while this was quite possible, measurements on biopsies had never revealed any increased water content He wondered whether Professor Davies could not check this point from measurements of post-mortem tissues

Professor PLATT believed that examination of muscle tissue would reveal a greater element of 'jelly-fish' tissue than did the liver The American research to which Dr Trowell had referred had not included work on nitrogen output Moreover, the cases involved had been subject to a few - up to ten - successive attacks of malaria in a short period of time and not to repeated attacks extending during the lifetime of the individual and possibly affecting successive generations (as was the case in West Africa), the pathological, biochemical and cytological changes in chronic malarial infections might be expected to be different from those of acute infections

Turning to the question of the regeneration of plasma protein in subjects outside the tropical area, he referred to the work of Kunkel and Ward[2] who had distinguished three groups of subjects, undernourished, normal and nephrotic Experiment had shown that when the esterase was destroyed by fluorophosphates the plasma esterase content returned to different levels - low, normal and high respectively The process in the last named was similar to that described by Dr Edington, where the organism adapted itself to increased requirements of iron

The possibility of modified biochemical mechanisms should be borne in mind in the study of both infant and adult cases of malnutrition Subjects on low protein diet might go, as it were, 'into low gear', they might, as Sprinson and Rittenberg[4] had shown by isotope (^{15}N) studies, for animals and man on low protein diets, utilize some 20 per cent of nitrogen for the synthesis of protein from the ammonia in the diet When the protein level was high ammonia nitrogen was not utilized

In this example the real efficiency of methionine is shown to depend on biological value and digestibility In the protein 'X' in which the deviation from standard is 100, methionine would have no effect *in vivo*, it would have to be catabolized and take no part in nitrogen metabolism In milk, the efficiency of methionine is calculated thus 3 x 0.95 x 0.95 = 2.7 and in maize the calculation is 3 x 0 8 x 0.3 = 0 72. From this it can be seen that, although the actual amount of methionine in milk and maize proteins is the same, its true efficiency is markedly different

Professor Jacquot referred to the breakdown of enzymatic systems, especially the equilibrium between the groups $-S-S- \rightleftharpoons -S-H$ If kwashiorkor resulted from an upset of this equilibrium, that is, from the inability to transform the oxidized to the reduced form, it should be possible to re-establish the oxidation-reduction equilibrium with the help of glutathione, which is the 'redox' substance capable of existing in either oxidized or reduced form He wondered if anyone had tried to treat kwashiorkor with glutathione and, if so, what were the results

Professor BROCK referred to that part of Professor Holmes's paper which dealt with the serum protein fractions of the blood A characteristic pattern of low albumin and high γ-globulin had been reported from many parts of Africa The explanation of the high γ-globulin might lie in the effects either of tropical parasitism, or of protein deficiency in the diet acting directly or through the intermediary of liver damage In Capetown the opportunity was provided to solve this problem because the local Bantu African population had never been subjected to tropical parasitism but had suffered from the same dietary pattern of protein deficiency as existed in Central Africa Further, they showed the same pattern of pigmentary cirrhosis He had used the same chemical technique as Professor Holmes for comparative purposes, but had also checked it against electrophoresis The γ-globulin of Africans in Capetown was distinctly higher than that of the Europeans but distinctly lower than that of Kampala Africans It seemed, therefore, that the high γ-globulin of African bloods could not be attributed solely to parasitism, but that probably both dietary deficiency and parasitism played a part

Dr TROWELL concluded from Professor Brock's observations in Capetown that further investigation in non-tropical regions would give helpful comparisons

He was able to quote some observations on serum proteins made in the Belgian Congo by the same chemical methods as were used by Professor Holmes in Kampala, they had been standardized by electrophoretic methods Normal Africans of different ages had been examined for serum protein and red blood cell counts The result showed that at birth the African came within the normal range for other races in both respects To account for the disturbance which occurred in later life and produced the characteristic low albumin and high γ-globulin content, would require more comparative figures

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Professor BIGWOOD said that the crucial temperature for complete inhibition of an enzyme system differed considerably from system to system, In the case of dehydrogenases it was around 55°C

He concluded that the answer to Professor Moncrieff's question was that, on the whole, changes in body temperature had probably but little effect on the enzyme activity studied by Dr Waterlow, considering particularly the fact that he had measured respiration and that the oxidase systems involved in that case were rather thermostable

Dr TROWELL thought there was another aspect to Professor Moncrieff's question children in fever were known to pass undigested food in the stools That raised the question of kwashiorkor symptoms in the presence of malaria or fever The work of Véghelyi in Budapest and the American literature had shown that there was a temporary depression of the pancreatic enzymes during infections The clinical aspect was reluctance to eat When the fever subsided the pancreatic enzymes recovered their normal activity, appetite returned and the food was once again digested

Professor PLATT pointed out that Professor Moncrieff's question had been directed to the effect of higher temperature directly on the enzymes and not on the body generally He had observed that during an attack of fever the digestibility of protein fell from 60 per cent to 40 per cent This reduction of digestibility was probably not directly due to the effect of temperature on the activity of the enzyme itself so much as on the amount of enzyme available for protein hydrolysis

Professor FRONTALI observed that beside the numerous metabolic studies of which they had heard and which had also been performed in starchy food dystrophy, he would like to draw attention to water and salt metabolism in a disease whose main feature was represented not only by oedema but also by hydrolability (alternate rapid gain and loss in weight due to retention and loss of fluid)

With his collaborator, Dr Passaro[3], he had obtained the ionogram for 20 cases of starchy food dystrophy It was found that sodium and chloride content, as well as alkaline reserve and serum albumin, were lowered proportionately more than potassium, which was slightly below normal, and the globulins were often increased The total milli-equivalents were reduced from the normal 150 to 155, to 131 to 138

An ionogram constructed from the average data of 20 cases of starchy food dystrophy compared with the ionogram of 20 normal infants in Rome showed fairly proportional reduction of sodium and chloride

The extracellular fluid, estimated by the sodium thiocyanate method, showed a very definite increase In normal infants the extracellular fluid was, on the average, about 20 per cent of the total body weight, in cases of starchy food dystrophy before treatment the extracellular fluid was between 27 2 and 41 5 per cent,

while in the cases in which it had been re-estimated during dietetic treatment with 'protein milk' it fell, without immediately recovering normal values, in 10 to 20 days

In starchy food dystrophy with conspicuous oedema there was (a) an ionogram showing a low value for the total milli-equivalent, i e a hypo-electrolytaenia, and (b) an increase in extracellular fluid from 1½ to twice the normal amount Whether the intracellular fluid in these cases was increased could not be determined and therefore comparison with the jelly-fish cannot be immediately accepted or denied In any case, the changes in extracellular fluid were in fairly close agreement with the variations in body weight, and the rapidity of these variations might perhaps be better explained by gain and loss of extracellular rather than of intracellular fluid

Professor GYORGY said that he had been puzzled by the peripheral fatty infiltration seen in kwashiorkor and unambiguously demonstrated by Professor Davies A low protein diet should lead to a centrilobular fatty infiltration He could find no reason for its location elsewhere The explanation might possibly be found in the endocrine factor the fat-mobilizing activity of the anterior pituitary could lead to peripheral infiltration

Another difficulty arose over the two preventive factors mentioned by Dr Lindan in connection with the production of experimental liver necrosis, they were cystine and vitamin E From the final fall of glutathione in necrotic liver it would be thought that cystine was a more effective preventive than vitamin E In fact that was not so vitamin E was superior in that respect Did Dr Lindan consider that cystine deficiency was responsible for the final drop in reduced glutathione found in necrotic liver?

Dr O LINDAN replied that the dietary protein deficiency determined the reduction of the GSH in the liver The GSH of the liver, however, could not fall below a certain level even in animals given a protein-free diet

It was held that when so-called 'dietetic necrosis' developed, the final fall in GSH found in necrotic liver was a general finding connected with the death of the liver Dead liver cells left in a living body contained very little GSH, irrespective of the cause of death

What he had wished to point out in his paper was that the level of liver GSH was a fairly sensitive indicator of liver damage For example necrotic (dead) liver of rats containing very little GSH, one-tenth of its normal value, no glycogen and no ascorbic acid, still contained large amounts of cholinesterase

Professor MAYNARD recalled the nitrogen balance studies made by Professor Platt and Dr Patwardhan He himself had done similar work both with animals and human beings in various parts of the world including China and Central America, he thought that data obtained

from studies based on liberal North American diets should be treated with reserve when it came to other races and different conditions

Professor Platt had demonstrated the larger nitrogen storage per kilogram intake of protein in the African than in the American child That suggested a higher degree of efficiency in protein utilization It was probable that in the African child, who had earlier been denied a high nitrogen intake, the higher utilization was necessary for the building up of reserves

He had no explanation to offer for the situation demonstrated by Dr Patwardhan, in which the transition from vegetable to animal diet led to higher output of nitrogen in the urea That observation challenged certain basic concepts Perhaps further studies should be made of quantities of amino-acid required per kilogram body weight for Africans and Indians, they might be different for different races

The indicator method used by workers in Africa and India was also used in the United States, it was found to be a sufficiently accurate way of determining digestibility without resorting to comparisons of food and faeces

Professor Holmes had experienced the same difficulty as Dr Patwardhan in accounting for nitrogen retention Could it be lost through sweat? He did not think so Was it subjected to bacteriological action and passed per rectum? It could soon be seen that the suggestion was absurd He could only suppose that as nitrogen went in, something else, water, or perhaps fat, came out He could not accept Dr Patwardhan's simplification that true nitrogen retention did not occur Unless the methods of investigation were at fault, retention was indisputable

Dr PATWARDHAN said that it was not a question of continuous retention, but of variation in urinary nitrogen output the output was smaller on a vegetable protein diet than on an animal protein diet

REFERENCES

1 Block, R. J. & Mitchell, H. H. (1946) *Nutr Abstr Rev*, 16, 249

2 Kunkel, H. G. & Ward, S. M. (1947) *J exp Med* 86, 325

3 Passaro, G (1953) *Boll Soc ital Biol sper*, 29, 245 248

4 Sprinson, D B. & Rittenberg D. (1949) *J biol Chem* 180, 707

Chairman Professor A. Raoult

FOOD CONSUMPTION IN THE GAMBIA

by

B. S Platt and M W. Grant

The pattern of food consumption in the Gambia is conditioned by two major factors, (a) inadequate total supplies resulting in a 'hungry season' which occurs in the period before the new season's crops mature, and (b) a *long dry season* during which fresh fruit and vegetables become very scarce. In one possibly important aspect, the Gambian diet differs from the usual African pattern the staple food, providing some 80 per cent of the total calories, is not constant throughout the year but may be any one of half-a-dozen different cereals, depending on season and supplies.

The agricultural year opens in April with the clearing and burning over of the land that is to be tilled No start can be made on preparing the soil until the rains come, as during the seven to eight dry months it has become too hard for the primitive hand hoes to make any impression Once the rains begin - which may be any time between mid-May and mid-June - the heavy work of preparing the land for the new crops must be done as quickly as possible. Even then, however, the soil is only easily worked with primitive hand tools to the depth of a few inches, and ridging is employed to provide a deeper layer for the roots of those plants which need it.

Rice *(Oryza sativa)* cultivation is particularly dependent on the rains as irrigation is not practised. *The* river is tidal for a considerable distance, not until the waters are well swollen by the rains is the down-flow of fresh water sufficient to prevent salt water spoiling the rice crops in the middle third of the river. By that time, however, the short agricultural season is well advanced *and it is too late for sowing seed. Rice is, therefore,* raised first in nurseries and then the young plants are transferred to the flooded river banks when the water there has lost its salty taste. This crop is cultivated almost exclusively by the women and it is unfortunate that it requires this extra time-consuming process as they are *hard enough pressed with routine duties*

The fact that the agricultural season is so sharply limited means that everyone - men, women and children - must work as hard and as fast as they can to ensure a reasonable supply of food for the *following year* This is the season at which the calorie shortage is most severely felt, as food stocks from the previous year are running very low and there is no time to search for supplementary foods in the bush. Even when food is available, however, the women are usually too busy in the fields and too tired when they return *home* at *night* to do the usual amount of pounding and cooking

Snacks are occasionally prepared and eaten in the fields but little is available until later in the season Then, as the waters recede from the rice fields, crabs, small fish and baby crocodiles are often caught and cooked on the spot. Before this time, the villagers appear frequently to work the whole day through with no food until the evening

A very young baby accompanies its mother to the fields and is an additional burden to her as it must be carried on her back while she works, older babies and toddlers are left at home in the care of girls about eight to ten years old, who are not yet strong enough to be much help on the land There is little doubt that these young children also go for hours at a stretch with very little food, or even none at all. This season - the beginning of the rains - is also marked by a great increase in malaria and other parasitic infections and is the time when most deaths occur.

In the second half of the rainy season calorie intakes remain low, and may drop below 1,000 Calories per head per day if the quick maturing crops such as maize *(Zea mays)* and findo *(Digitaria exilis)* fail, but there is a plentiful supply of fresh green leaves and the people have time to collect wild bush foods to eke out their home supplies Energy requirements are less, as the main agricultural occupations are confined to weeding and guarding the growing crops

Harvesting and carrying back the grain to the villages are further heavy tasks which occur towards the end of the year, but more food is certainly eaten at this time Pumpkins *(Cucurbita* spp) and fresh maize cobs, which require very little preparation, are popular and the women and children prepare an attractive snack by parching grains of new rice in a dry pot and eating them without further cooking.

The turn of the year is the time when the diet is most satisfying Tomatoes *(Lycopersicum* spp), okra *(Hibiscus esculentum)* various leaves, and groundnuts *(Arachis hypogaea)* are all plentiful, and the amount of grain eaten is only limited by the thought of another hungry season looming ahead Physical activity is at a minimum except for those families which have cotton to harvest and spin

By March the diet is decidedly poor, although calorie intakes may be higher than in the autumn, meals consist almost entirely of cereals and a few groundnuts, no fresh material being available apart from a few bush fruits which are eaten mainly by the children Mangoes *(Mangifera* spp) and pawpaws *(Carica papaya)* would be a great help at this season but, so far, few families possess these fruit trees although the fruits appear to be well enough liked

The main cereals grown are bulrush millet *(Pennisetum* spp) guinea corn *(Sorghum* spp) and rice Rice is also imported but this is, unfortunately, usually highly milled grain and increases the

risk of beriberi in this predominantly cereal-eating community Maize, findo and jajeo *(Acrocera amplectans)* are grown in small quantities for use in the hungry season before the main crops have matured, the maize being eaten almost entirely as corn-on-the-cob.

Table 1 sets out the frequency of use of different foods in compounds surveyed in Yoro Beri Kunde in 1945-6, and in Genieri in 1949. The greater use of rice by the Genieri villagers, in preference to the older staples, is an indication of their higher degree of sophistication This is also reflected, though still on a very small scale, in their greater use of sugar and their lesser use or tolingo, a traditional preparation from fermented locust beans *(Parkia filicoidea)*. It is believed that the Yoro Beri Kunde dietary pattern is more typical of Gambian villages in general than the Genieri one, though the latter is possibly more like those of villages near the town of Bathurst.

Table 1

Frequency of use of different foods

Number of times used in the course of one year

	Yoro Beri Kunde	Genieri
Rice	243	602
Pennisetum millet	237	114
Sorghum	241	28
Maize	49	3
Findo[1]	14	14
Baobab fruit	-	260
Cassava tuber	3	31
Nette[2]	rarely	36
Groundnuts	394	552
Tolingo[3]	89	45
Peas and beans	3	1
Fresh green leaves	310	92
Dried baobab leaf	51	136
Okra	205	17
Tomatoes	55	174
Pumpkins	14	4
Peppers	27	-
Onions	4	10
Fresh meat	89	24
Dried meat	30	-
Fresh fish	5	123
Dried fish	38	278
Milk	34	4
Oil	40	83
Sugar	7	17
Honey	4	1

[1] *Digitaria exilis*

[2] the yellow powder in *Parkia* pods

[3] fermented *Parkia* seeds

The calorie value of the dietaries recorded in different compounds at different times of the year ranged from 1,240 to 2,760 per head per day in Yoro Beri Kunde, and from 1,083 to 3,243 in Genieri, cereals and groundnuts together supplied approximately 90 to 95 per cent of the total calorie intake.

Table 2 shows the estimated average calorie and nutrient intakes in the two villages, for Yoro Beri Kunde from September 1945 to July 1946, and for Genieri from January 1948 to December 1949

Table 2

Average Calorie and nutrient intakes per head per day

	Yoro Beri Kunde	Genieri
Calories	1,934	1,764
Proteins, g	53	50
Fats, g	21	37
Calcium, mg	260	382
Iron, mg	19	7
Vitamin A, i.u.	62	3
Carotene, mg	2.0	2.0
Ascorbic acid, mg	28	41
Thiamine, mg	1.6	1.0
Riboflavin, mg	0.6	0 5
Nicotinic acid, mg	15.8	18 3

The main differences are due to the greater use of milled rice and groundnuts in Genieri, this raises the intake of fat and nicotinic acid but depresses the iron and thiamine. The main sources of calcium are dark green leaves, particularly those of the baobab tree *(Adansonia digitata)*, and fish bones. This second source was of minor importance in Yoro Beri Kunde, where fish was seldom eaten, but was of considerable importance in the Genieri dietaries

Riboflavin intakes may be a little higher than the figures given in table 2 The local method of preparing grain results in early germinative changes taking place and these certainly seem to increase the amount of B_2-complex vitamins present, but a more detailed study is required to determine the extent to which they are increased.

There are many traditional ways of processing foods which might be expected to enhance their nutritive value a separate communication (page 271) deals with the extremely widespread practice of fermentation by yeasts, moulds and autogenous enzymes, the full significance of which is not yet known

The main sources of proteins are cereals and groundnuts. The more concentrated protein foods, such as meat and fish, are scarce and erratic in supply Most Moslem families try to have milk during Ramadan but use it little or not at all at other times of the year. Cattle-owning Fula families certainly use more milk but yields appear to be low and there is an undoubted difficulty in rearing the calves if much milk is taken for human consumption

Questioning of women in the villages elicited the information that an attempt would be made to obtain goat's milk for an infant whose mother was unable to feed it herself, but it was not considered necessary for other children to have anything but ordinary family meals once they were ready for solid food Breast feeding is normally continued for eighteen months to two years, supplementary feeding starts with a little cereal pap 'when the child can sit upright by itself' and more solid food is given 'when it reaches out a hand to the calabash at meal times' The practice, common in East and Central Africa, of giving starch paps from a very early age does not appear to be prevalent in the Gambia.

There is, however, the usual difficulty of providing a suitable diet at weaning time. Quite apart from the question of the biological value of the proteins in the foods that are available, the protein calorie ratio in the typical Gambian diet is too low to sustain a good rate of growth in the young child, and the quantity that would have to be eaten to supply enough essential amino-acids would be beyond the physical capacity of its stomach. For the same reason it is difficult to devise adequate diets for pregnant and lactating women without increasing the bulk and the total calories far beyond their needs. In practice, of course, the amount of food available is often not enough to meet even normal requirements, and the possibility of supplying the enhanced protein needs of the 'vulnerable groups' is very slight indeed

INFANT FEEDING AMONG THE YORUBA OF IBADAN

by

D. B. Jelliffe

Ibadan, the principal town of Yorubaland in Western Nigeria, is made up for the most part of crowded, crumbling, unhygienic mud-brick buildings and has an estimated population of about half a million It has been the site of an African town of considerable size for over a hundred years, and it is at present important as the centre of the cocoa growing region of Nigeria The vast majority of the inhabitants are Yoruba, and all mothers and infants in the present survey were of this tribe

Yoruba diet, admirably outlined by Bascom[1], contains very little animal protein, and this is especially so among the poorer women of Ibadan town There are usually no special foods reserved for pregnant women or lactating mothers, although, according to Onabamiro[8], in some villages in Yorubaland edible snails, African mudfish and palm wine are particularly kept for them This certainly does not appear to be so in Ibadan town itself, as has been emphasized by Woodruff[13] who found that it was unusual for pregnant women in Ibadan to have more than two to three ounces (57 to 85 grams) of animal protein a week, while many only have about one ounce

In the present investigation, all the mothers were poor, hardworking and ill-nourished They were usually responsible for their own upkeep, working as petty traders, or on small farms or plots outside the town All were almost completely illiterate and uneducated, such sophistication as they had being of a very superficial character, frequently acquired from little understood and often misleading advertisements A superstitious attitude to life was universal, as was reflected by a recent examination of over 200 consecutive infants in the outpatient department when more than 75 per cent were found to have at least one amulet or charm round the neck, arm or wrist

The present paper is an attempt to outline the current practice with regard to infant feeding among the Yoruba of Ibadan It cannot be contended that the findings necessarily apply to other parts of Yorubaland, in fact this seems unlikely as in smaller, remote settlements one finds, as might be expected, a closer adherence to tradition, and also there is considerable variation in different districts and among other divisions of the Yoruba tribe (e g the Egba of Abeokuta) The present findings can, therefore, only be regarded as a mixture of facts and impressions collected during the last four years actually in Ibadan town

Feeding during the first few weeks When a Yoruba child is born the cord is severed as soon as the placenta has been expelled Ligature with a length of thread is sometimes effected, and dressings with coconut oil and charcoal, or palm oil are applied Following this, the baby is bathed in a lukewarm herbal bath and then oiled

Next, according to Onabamiro7, the infant is exercised somewhat strenuously - the grandmother or old woman in attendance throwing it up 'for a distance of about two feet from her hands and grasping it by the arms as it falls' This is repeated two or three times, following which the baby is gently swung by each leg and arm in turn.

Following this preliminary treatment the first feed is given This consists of 'agoo-omo', a herbal decoction prepared from an elaborate and probably variable mixture of barks, roots and dried leaves This is given to the child by forced hand-feeding, as will be described later The correct volume of the feed is assessed by the degree of abdominal distension produced

The breast is given immediately after the bath and the agbo feed Thereafter, during the first few days, agbo is given three times daily at approximately 6 a m , 12 noon and 6 p m Breast feeds are given after each agbo feed and in addition whenever the baby cries or shows signs of discomfort Water, as such, is not given for the first 30 days or so

The pharmacological action of agbo, if any, is unknown. It has been suggested, with no evidence, that it may contain an anti-malarial substance Agbo certainly seems to have a laxative action, and some preparations occasionally produce severe diarrhoea

Breast feeding Feeds are given 'on demand' from the first day onwards * Either breast is used haphazardly and the child is suckled in any position, even while slung on the mother's back as she walks along, the baby being able to reach the long, pendulous breasts through the axillae Lactation, at least early on, is always adequate and often hyperabundant, two small calabashes being tied to the breasts to collect the overflow No case of inadequate early lactation has been seen in the last four years, and breast feeding is always carried out without difficulty unless some local condition such as mastitis or a breast abscess, or a severe general disease, prevents it

The length of time for which African babies are breast fed has been variously estimated by different observers It is difficult to assess accurately in a very changeable, frequently unco-operative population, especially as ages are rarely known exactly There is, nevertheless, general agreement that African babies do continue to have breast feeds for several years In order to clarify the position among Yoruba children, 208 consecutive infants of known age were observed in the infant welfare clinic All were between the ages of one month and two years In every child, breast feeding was being continued, although in the older groups other foods were also being given, as will be discussed later

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* The recent trend in infant feeding in Europe and America is towards this self-determining method by which many observers, including Illingworth 3 and his associates, have shown that the majority of babies automatically adjust themselves to six or seven breast feeds daily

Amounts of milk expressed from breasts of Yoruba mothers nursing infants 8 to 14 months old

Case No.	Age (months)	Amount (per 24 hr.)		Diet of infant
		oz	g	
1	8	10	284	Breast milk only
2	14	12	340	Breast milk and maize gruel
3	9	11	312	Breast milk
4	12	7	198	Breast milk and maize gruel
5	12	4	113	Breast milk and maize gruel
6, 7 Twins	9	14	397	Breast milk

It is a commonplace that in tropical Africa premature babies and those whose mothers die during labour stand little chance of surviving. Unlike the traditional attitude of the Ibo of Eastern Nigeria, twins are welcomed among the Yoruba Ododua, mother of the gods and the goddess of fertility, is generally represented as a mother nursing twins However, the additional hazard is emphasized by the results of the writer's observation in Ibadan of fourteen sets of twins for the first nine months of life In ten of the families, at least one of each pair died and, in some cases, both babies In this context a curious and previously undescribed condition may be noted This is known in Yoruba as 'dada' and is particularly common in twins, usually being seen in the weaker, smaller and more ill-nourished of the two The condition is evident at birth and consists of long, usually brown, rather fine hair which is conspicuously twisted into tight screwed-up tufts The appearance is quite striking (plates 53, 54) As far as could be detected the parents did not exaggerate the condition by curling the hair themselves The whole picture becomes even more obvious when the child grows, as, according to Yoruba custom, hair of this type must not be cut, combed or unravelled until suitable propitiation ceremonies have been observed, otherwise death will result The cause of this condition is unknown, but it only seems to occur in small, weakly malnourished infants The possibility of its being due to foetal malnutrition must be considered, although, in children whose hair is not cut, 'dada' seems to persist at least as late as the fourth year of life even if they have become well-nourished by this time Indeed, in surviving children with 'dada' this condition may cause confusion with the dyspigmented hair of kwashiorkor, but it can be easily differentiated by the tight, intercurled, tufted appearance

As, unfortunately, it is unusual for children to continue attending the infant welfare clinic after the end of the second year of life, and as the other age check of compulsory birth registration is not operative in Ibadan, it is only possible to make a rough estimate of the age at which these Yoruba infants cease to take the breast Onabamiro[8] is of the opinion that between two and three years is the most usual period, although there is no absolute rule and children older than this are seen occasionally at the breast This view, with which the writer agrees, is supported by the fact that the traditional Yoruba spacing between babies is three years, and sexual abstinence is supposed to be practised for 27 months after the birth of a child, which is more or less the time during which it is being breast fed While this custom is certainly not now so widespread, there seems good evidence that it is still commonly practised, and in some cases it is enforced by sending the nursing mother to live with her parents for this period

The effect *per se* of prolonged lactation on the mother's health and, in particular, on her nutrition, is virtually unknown Certainly it is remarkable that more evidence of maternal protein deficiency is not seen In addition, such investigations as have been made have shown comparatively little alteration in the composition of the milk secreted by these late-lactating and inadequately nourished women, although little work has been undertaken and that has been mainly on the cruder elements such as protein and fat In Ibadan, recent analyses of breast milk from 76 Yoruba nursing mothers showed an average protein content of 1 04 per cent (range 0 59 to 1 76 per cent) which compares not unfavourably with recent figures from better fed parts of the world The length of lactation in this group varied from 1 to 36 months No evidence could be found of a decrease of protein content with length of lactation[6]

While it is quite possible that breast milk may become qualitatively deficient in late lactation (e g in vitamin content and amino-acid composition) quantitative deterioration is more likely As will be appreciated, under African conditions this is difficult to measure, as mothers would certainly neither understand nor co-operate Recently, however, seven infants, including one pair of twins, were admitted to the ward suffering from gastro-enteritis, for which preliminary starvation was required for the first 24 to 48 hours During this period the breast milk was fully expressed every three hours and the daily output measured and although the figures shown in the table are only approximate they nevertheless indicate clearly that yields may become very small, possibly quite early on

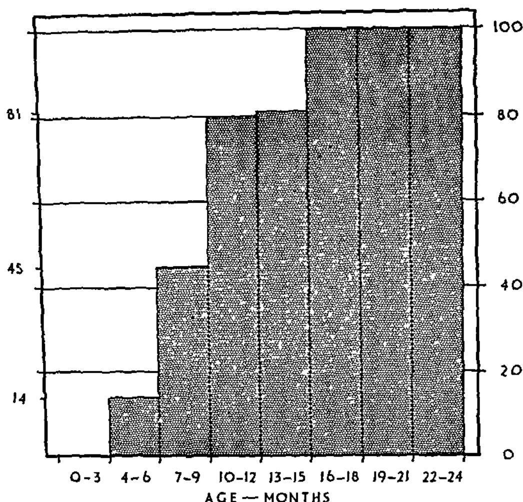


Fig 1 Percentage of children in different age groups having solid or semi-solid food

In the whole group having mixed feeding the following foods were being used with the frequency indicated gruel made from maize (*Zea mays*), 100 per cent, boiled yam (*Dioscorea* spp) and porridge made from yam flour, 40 per cent, bread, 30 per cent, boiled rice (*Oryza sativa*), 20 per cent, gruel made from cassava meal (*Manihot utilissima*), 12 per cent A few babies were being given beans and gruel made from guinea corn (*Sorghum vulgare*), the latter being considered a particularly good, but expensive, food for weakly or convalescent children Oranges (*Citrus sinensis*), pawpaws (*Carica papaya*) and eggs were very rarely used and in no case was meat or fish being given. In almost every instance, maize gruel was the first food given, followed by other starchy pastes and then by actual solids Traditionally among the Yoruba, children are not given solid foods until two upper and two lower incisors have appeared Two of the

When a Yoruba mother dies during labour, the baby is suckled by a relative or occasionally a neighbour, professional wet-nurses being unknown Usually these women are already lactating, but sometimes it seems certain that lactation is artificially induced In Ibadan numerous examples have been noted in the last four years, although it must be conceded that the actual period of onset of lactation has never been closely observed However, lactating women have been seen who had had no children of their own for up to 12 years previously, several of whom had indeed passed the menopause However, all had had children of their own The method used to initiate lactation consisted of putting the baby to the breast, bathing the breasts with a brew of mixed herbs and drinking native herbal medicine

Very occasionally attempts may be made to feed motherless new-born babies in their homes using dried cow's milk These attempts are rarely successful, gastro-enteritis, marasmus and death following almost inevitably The elaborate precautions of boiled water, clean bottles and correct formula strength are impossible under African living conditions in Ibadan

Weaning As has been stressed by Brock and Autret[2] in their recent survey of kwashiorkor in Africa, there is a considerable degree of uniformity in the dietary pattern and methods of weaning employed throughout tropical Africa Nevertheless, as they say, much more detailed information is required from different areas, and the following attempt has therefore been made to investigate the practice of weaning as seen in Ibadan

Owing to the lack of any accurate measurement of time by local mothers, it was found to be useless to question them as to when their children had been weaned in the past Occasionally reasonably accurate dates could be fixed, when suitable time-marking incidents could be recalled, such as 'last year during the time of the salt shortage' or 'two Ramadans ago', but this was exceptional The problem is further complicated by the fact that the Yoruba month is lunar In view of these difficulties, the mothers of 208 infants of ages varying from 1 to 24 months were questioned and observed in the infant welfare clinic to discover what in fact the children were eating at the time of examination By subdividing these into three-month age groups, it was possible to find out when solid and semi-solid food was being introduced into the diet In 14 per cent, supplementary food was introduced between the ages of 4 and 6 months, while in the 7 to 9 month age group 45 per cent were having food other than breast milk From the age of 10 to 15 months about 80 per cent, and from 16 to 24 months, 100 per cent were taking solid or semi-solid foods (figure 1) As has been noted previously, in every case this was in addition to breast milk

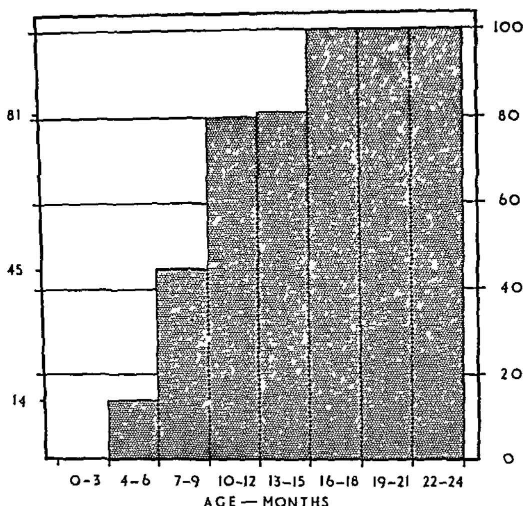


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foods mentioned, rice and bread, are quite new to Yorubaland They are much less used outside the large towns but they are an indication of the way local diet is being modified by foreign foods

During the first two years of life, little is given besides breast milk and the various starchy foods already mentioned, although older infants may have a valuable dab of vegetable stew from the communal pot Fruits are rarely given, and of these pawpaw is certainly the most common Palm wine is never given except medicinally Once the Yoruba child is quite off the breast, he gets his share of the family stew and his diet is thereby improved although it still remains predominantly carbohydrate in nature No special foods are prepared exclusively for children

Certain foods are considered to be unfit for, or actually harmful to, infants Sweet things such as sugar are thought to produce diarrhoea and 'jedi jedi', or protrusion of the anal mucosa during defecation which, although an apparently harmless incident, seems to worry Yoruba mothers very much and is one of the commonest minor reasons for attending infant welfare clinics Meat is thought to produce worms if eaten before the age of two years or so, plantains and oily or peppery dishes are considered to be too indigestible Eggs are suspected of causing diarrhoea and, if eaten too often, of possibly making the child become a thief later in life

In Ibadan, infants are quite often fed with a spoon, but many poorer mothers still use forced hand-feeding Water, maize gruel or other liquid food is poured from the mother's cupped hand or from a gourd onto the side of the infant's face rather than into his mouth, while the child is pinioned across the mother's knees with his head down During this procedure choking always occurs and food may pass into the respiratory tract The possibility of this resulting in bronchopneumonia has been emphasized by Smith[11], who found histological evidence of cellulose foreign bodies at the centre of pneumonic patches at post-mortem examination of Nigerian infants in Lagos According to Onabamiro[8], in more old-fashioned families 'tongue-feeding' is still practised In this, the mother chews the food into pulp and then transfers it to the baby's mouth with her tongue

Artificial feeding Fresh cow's milk is unobtainable, while the present type of goat kept in Ibadan is not milkable and, as far as the writer could discover, the idea of drinking goat's milk is repugnant to the Yoruba

Investigation of the present group of 208 infants showed that the surprisingly high figure of 13 per cent of the total were taking, or had at some time taken, prepared cow's milk in one form or another A few were having condensed milk, while the majority were having dried milk This was usually the 'full-cream' variety and occasionally 'humanized' However, further enquiry showed the situation to be far less satisfactory than might at first be assumed Questioning of the mothers showed that few had any real idea of how the milk should be given and the majority did not appreciate that the powder

was dried milk but thought that it was a sort of medicine. The strength of formula used varied tremendously. Feeding bottles were seldom used. Economically, it was quite impossible for these mothers to continue giving even infrequent feeds of 'artificial' milk for long, and it may be noted that the cost of feeding a baby completely on dried milk would take more than their total earnings.

It must be stressed that the majority of mothers usually abandon 'artificial' milk after a very short while as they notice the constant association with diarrhoea which is produced by using inadequately mixed or contaminated milk or milk of the wrong strength. It is worth recalling that gastro-enteritis is probably the main killing disease in African infancy. 'Artificial' milk, with its present careless usage and the extreme likelihood of dust and flyborne contamination, is not an unmixed blessing.

Discussion

The present survey shows that infant feeding in Ibadan fits into the generally accepted pattern found in most of tropical Africa. Breast feeding is continued for at least two years, stopping usually between the age of two and three. Supplementary food is introduced rather earlier than is usually considered to be the case in West Africa, and consists almost exclusively of starchy paps. Feeding with preparations of cow's milk is attempted spasmodically by some, but continued by very few, and plays a negligible part in the infant's diet.

The classical textbook nutritional disorders are rarely seen in Yoruba children in Ibadan. Infantile scurvy, vitamin A deficiency and neonatal beriberi have not been observed in the last four years. Florid rickets is very rare and although minor degrees of vitamin D deficiency are not uncommon, they are self-limiting and of no real importance[4].

Kwashiorkor is undoubtedly the commonest and most serious nutritional disease seen in children in Ibadan. During 1950, 44 cases were admitted with this condition and of these, 28 were between the age of 18 months and three years, when they would all be receiving solids and semi-solids (figure 2) and many would still be having small, probably quite inadequate, amounts of breast milk. This figure agrees well with Trowell's[2] analysis of 1,000 cases of kwashiorkor seen in Uganda, when he found 69 per cent to occur between the ages of one and three years.

As well as the liver damage occurring in frank cases of kwashiorkor, biopsies have shown that the livers of Yoruba infants in Ibadan may be grossly abnormal histologically during the first few months of life, and even during the neonatal period, and this may possibly be traced back to maternal, and hence foetal, malnutrition[10].

An additional disease of African infancy which undoubtedly has a nutritional basis is the syndrome of infective gangrene of the mouth *(cancrum oris)*. In Ibadan this is very common and a recent analysis of 53 cases[5] has shown that admissions for this condition tend to rise during the 'hungry months' at the end of the dry season and at the beginning of the rains (figure 2) The age incidence is similar to, although slightly later than, that of kwashiorkor, and occasionally the two conditions occur together (plates 55, 56)

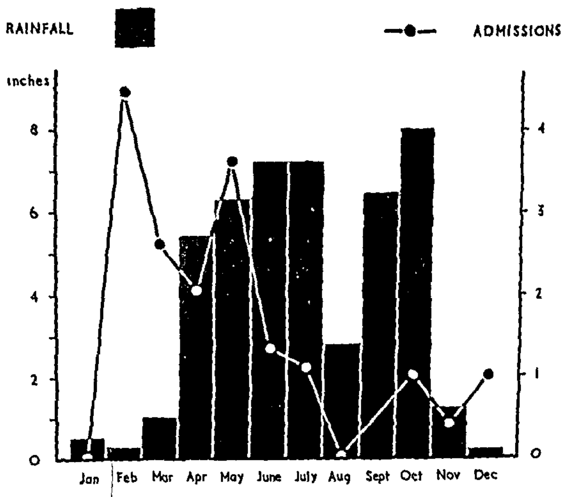


Fig 2 Relationship of admissions to hospital with infective gangrene of the mouth and seasons of the year (represented by rainfall) Average figures for the years 1949 to 1951, Ibadan, Nigeria

Although it may be decades before adequate meat, fish or fresh milk become available, numerous other minor but cumulatively important modifications of the present Yoruba infant diet are advisable

Two helpful and nutritionally important customs which should be encouraged and continued are the habits of prolonged breast feeding and sexual abstinence during lactation

In addition, as Brock and Autret[2] have noted, some staples are more often associated with kwashiorkor than others, cassava and maize being more often implicated than yams and rice The latter should therefore be advised, especially as local rice is coarsely milled, although unfortunately it is relatively expensive, as it has to be transported from the coastal districts Whatever the actual food given, it should be started in the fourth to sixth month of life, so that at least the infant's intake of calories, if not of protein, is sustained.

Of local foods, beans and eggs should be recommended for the older infant, especially eggs, which in Ibadan appear to be the only immediately available, though small, source of animal protein

As has been remarked, bread is beginning to play a part in the diet of the town-dwelling Yoruba It would, therefore, be preferable for the flour imported for bread-making to be of better nutritional value than the very refined product at present in use To improve its nutritional value it would be necessary either to increase the extraction rate or to 'ennoble' the flour by the addition of food yeast (and possibly calcium) as recommended by Platt[9] for the West Indies

The provision of subsidized skimmed milk, fortified with iron and suitable vitamins, would be of the greatest value, although considerable care would be required in distribution and handling to avoid its deviation into the black market, as has happened so often with the sulphonamides and antibiotics Explanation of how to use the powdered milk would have to be clear, repeated and standardized Instructions in the vernacular on the tin would be useful

Skimmed milk is much less likely to produce dietetic diarrhoea than is the full cream variety, and, as Platt[9] says, the need for butter fat and the fat soluble vitamins is not as urgent as in temperate climates It should probably be reserved for children from the age of six months to three years, unless very large supplies were available, for, by the end of this period, the stress of acquiring some degree of malarial immunity will be over, and the child will probably have begun to share in the family meals

The likelihood of the dried milk's becoming contaminated, which is very high when large tins are used, might be minimized by having the milk powder sealed in paper envelopes and packed inside the tins

There is the possibility that a soup powder composed of dried milk, pulverized groundnuts *(Arachis hypogaea)* bone meal, flavouring, etc , might form a cheaper, more acceptable and palatable supplementary food It must be remembered that the majority of African mothers are not used to the idea of cow's milk, even in its natural

form, as a food for their infants and, therefore, both dried milk and soup powder would be equally novel and strange

Summary

An investigation of infant feeding among the Yoruba of Ibadan town showed that breast feeding was begun on the first day of life and continued until the child was at least two years of age, probably being discontinued between the ages of two and three The yield of breast milk was shown to be very low in a small group of late-lactating Yoruba mothers A condition, possibly nutritional in origin, known as 'dada' is described Supplementary feeding with starchy paps was found to begin rather earlier than is usual in West Africa, although there was considerable variation At 4 to 6 months 14 per cent, and at 16 to 18 months and after, 100 per cent of the infants were receiving solids and semi-solids The various foods used are described, and suggestions are made to improve present methods

REFERENCES

1 Bascom, W. R (1951) *Africa*, 21, 41

2 Brock, J. F. & Autret, M. (1952) *Bull World Hlth Org* , 5, 1

3 Illingworth, R. S , Stone, D. G. H., Jowett, J. G. & Scott, J F. (1952) *Lancet*, 1, 683

4 Jelliffe, D B. (1951) *Trans R Soc trop Med Hyg* , 45, 119

5 Jelliffe, D. B. (1952) *Pediatrics, Springfield*, 9, 544

6 Jelliffe, D. B. (1952) *Brit med.J* , II, 1131

7 Onabamiro, S. D (1949) *Why our children die*, Methuen, London.

8 Onabamiro, S. D (1952) *Personal communication*

9 Platt, B. S. (1946) *Nutrition in the British West Indies*, Colonial No 195, H M S O London

10 Silvera, W. D. & Jelliffe, D B. (1952) *J trop Med (Hyg)*, 55, 73

11 Smith, E. C. (1943) *Trans R Soc trop Med Hyg* , 36, 287

12 Trowell, H. C (1952) *Quoted by Brock & Autret (1952) Bull World Hlth Org* , 5, 5

13 Woodruff, A. W. (1951) *Brit med J* II, 1415

DIETARY FACTORS IN KWASHIORKOR IN BASUTOLAND

by

K E A Underwood Ground

LOCAL AND SEASONAL VARIATIONS[2]

Maize *(Zea mays)*, Kaffir corn *(Sorghum* spp *)*, and wheat *(Triticum* spp *)* are all grown in Basutoland but make very different contributions to the dietary The Basuto of the plains seem to prefer maize and they sell other cereals in order to buy more of it, only eating sorghum or wheat when maize is unobtainable In the mountain areas all three grains have a regular place in the diet, much of the sorghum being made into beer (Joala)

Meat and milk are scarce in the lowland plains, a much better supply being available in the mountains In the winter months, milk, eggs and fresh vegetables tend to disappear entirely from the dietary in the lowland areas, and maize meal is frequently the only food that can be obtained It is towards the end of this period that the incidence of pellagra increases, followed almost immediately by the appearance of kwashiorkor, both diseases lessening again towards the end of the year as the diet improves The diet in the mountain areas is not so drastically curtailed in winter and kwashiorkor is only rarely encountered there

The incidence of kwashiorkor thus appears to be subject to the same influences as that of pellagra and it would seem that, in Basutoland, the consumption of maize plays an important part in its aetiology In this connection, the observations of Waterlow and Webb[3], made in the course of an investigation into the causes of a seven-fold increase in pellagra in Basutoland between 1936 and 1946, may be of importance They emphasized the possible influence of the changes that were taking place in the methods of preparing the maize for consumption In 1936 there were 16 hammer-mills in the Territory and by 1946 the number had increased to 46 It is to this type of mill that the vast majority of the Basuto now take their maize, and the meal that is produced contains the whole of the grain, whereas when maize was ground at home the bran was removed

CHILDREN'S DIETS

Diet histories were obtained for the 26 cases of kwashiorkor referred to on page 52 and for a number of healthy children selected at random In both series 'mealie meal' (maize meal) was the main item in the diet but the healthy children were all having meat, milk, eggs bread and vegetables in addition Of the 26 kwashiorkor cases, 14 were having nothing but mealie meal and the other 12 were having a little meat, milk or egg added only on rare occasions No child with kwashiorkor was receiving breast milk whereas in the healthy group, children of 18 months and two years were still being breast fed in addition to receiving a reasonably good mixture of supplementary foods

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Summary

An investigation of infant feeding among the Yoruba of Ibadan town showed that breast feeding was begun on the first day of life and continued until the child was at least two years of age, probably being discontinued between the ages of two and three. The yield of breast milk was shown to be very low in a small group of late-lactating Yoruba mothers A condition, possibly nutritional in origin, known as 'dada' is described Supplementary feeding with starchy paps was found to begin rather earlier than is usual in West Africa, although there was considerable variation At 4 to 6 months 14 per cent, and at 16 to 18 months and after, 100 per cent of the infants were receiving solids and semi-solids The various foods used are described, and suggestions are made to improve present methods

REFERENCES

1 Bascom, W. R. *(1951) Africa,* 21, *41*

2 Brock, J. F. & Autret, M. *(1952) Bull World Hlth Org* , 5, *1*

3 Illingworth, R. S., Stone, D. G. H., Jowett, J. G. & Scott, J. F. *(1952) Lancet,* I, *683*

4 Jelliffe, D. B. *(1951) Trans R Soc trop Med Hyg* , 45, *119*

5 Jelliffe, D. B. *(1952) Pediatrics, Springfield,* 9, *544*

6 Jelliffe, D. B. *(1952) Brit med. J* , II, *1131*

7 Onabamiro, S. D. *(1949) Why our children die, Methuen, London*

8 Orabamiro, S. D. *(1952) Personal communication*

9 Platt, B. S. *(1946) Nutrition in the British West Indies, Colonial No 195, H M S O , London*

10 Silvera, W. D. & Jelliffe, D. B. *(1952) J trop Med (Hyg),* 55, *73*

11 Smith, E. C *(1943) Trans R Soc trop Med Hyg* , 36, *287*

12 Trowell, H. C. *(1952) Quoted by Brock & Autret (1952) Bull World Hlth Org* , 5, *5*

13 Woodruff, A. W. *(1951) Brit med J* , II, *1415*

AMINO-ACID CONTENT OF CASSAVA MEAL

by

E. J Bigwood and E L Adriaens

Although there are many reports available on the general composition of cassava (*Manihot utilissima*) little is known about its amino-acid content This is, however, of considerable importance as cassava is the staple food of large numbers of people in the Belgian Congo and elsewhere, and in many instances it provides a very high proportion of the total calorie intake It is known, for example, that adults may consume as much as three-quarters to one kilogram of cassava meal daily and this alone would provide 2,600 to 3,500 net Calories It follows, therefore, that the protein ration of the people concerned is also predominantly influenced by this food, notwithstanding its very low nitrogen content

One of us (E L A) has collected extensive information on African foods[1] and has found that in the Belgian Congo the total nitrogen content of cassava meal varies from 0 13 to 0 48 per cent on a dry weight basis This is equivalent to 0 76 to 2 8 per cent of crude protein (using the conversion factor of 5 83) Van Veen and Lanzing[14] claim that 47 to 54 per cent of the nitrogenous material is in the form of proteins and they believe that the remainder is chiefly composed of ammonium salts, asparagine and glutamine (fraction soluble in hot water) Kiger[7] claims that 50 to 60 per cent of the nitrogenous material in commercial cassava meal preparations is not protein

Sreeramamurthy[11] has analysed fresh cassava roots grown in India, he reports that 81 6 per cent of the total nitrogen can be extracted in water but that only 21 8 per cent can be precipitated with phosphotungstic acid He refers to this latter fraction (which corresponds to only a little over one-fifth of the total nitrogen) as the protein fraction and regards the rest as non-protein in nature It is doubtful whether these fractions are correctly named since amino-acids were present in the hydrolysates of both fractions and the estimates of the quantitative distribution of nitrogen between the two are obviously inconsistent Tyrosine, tryptophan and cystine are reported as being more or less evenly distributed between the two fractions, in amounts smaller than 3 per cent of the total nitrogen of the entire product, histidine is claimed to provide 4 5 per cent and lysine 11 6 per cent of the total nitrogen, both being located entirely in the so-called 'non-protein fraction', arginine is considered to account for 20 7 per cent of the total nitrogen and to be present mainly in the protein fraction The terminology and the quantitative data given in Sreeramamurthy's report provide a very confused picture

In our own experience[4] the amount of ammonia nitrogen present in cassava meal is extremely variable and may exceed 10 per cent of the total We found that between 33 and 100 per cent of the total nitrogenous constituents could be salted out with a 0 5 per cent

Among the Bantu the native custom of not allowing a child to eat meat until a godfather has been chosen sometimes leads to delay in the proper supplementation of the infant's diet at the weaning period There does not appear to be any fixed time in the child's life for this ceremony so that some children have to wait much longer than others before the addition may be made and, although the restriction only applies to the eating of meat, many mothers seem to postpone the addition of other foods also, until the godfather has been appointed

The Basuto convention which affects the duration of breast feeding is that the mother is forbidden sexual intercourse for a period of 12 to 24 months after parturition but should she become pregnant again she should stop feeding the first child Soft mealie meal porridge ('lesheleshele') is the item of diet considered most suitable for a child newly off the breast, this given alone provides an inadequate supply of proteins to meet the needs of the growing child

The importance of prolonged breast feeding seems obvious, two years is common and although the amount of milk obtained towards the end of this period may be small it is probably just sufficient to prevent severe protein deficiency in the child Although Gelfand[1] reported kwashiorkor in a breast-fed infant, the child was only three months old and had been given mealie meal porridge from the day of its birth At this early age, the requirements for protein relative to total calories are of course, even higher than at the age of 18 months to two years The average time between removal from the breast and the onset of kwashiorkor in children under the age of 2½ years is approximately four months and the age of maximum incidence is between two and four years

REFERENCES

1 **Gelfand, M** *(1951) Trans R Soc trop Med Hyg* **45** *393*

2 **Ground, K E A Underwood** *This Report p 267*

3 **Waterlow, J C & Webb, R A** *(1947) Pellagra in Basutoland Interim Report Colonial Medical Research Committee obtainable from the Applied Nutrition Unit London School of Hygiene and Tropical Medicine*

It was felt that the presence of ornithine in a foodstuff, particularly in such relatively large quantities and in a material of vegetable origin, required further investigation We were interested in finding out whether this unexpected constituent was present in the fresh cassava roots or appeared during the process of de-bittering[2]

It was found (a) that in non-processed roots there is only a small amount of free ammonia (ammonium salts), hardly any ornithine but a large proportion of arginine, (b) that in de-bittered material there is usually, though not always, a large amount of free ammonia, relatively large amounts of ornithine and very much less arginine, ornithine may also be found in preparations which have not been de-bittered by soaking but which have been dried in the sunshine in the open air for several days, (c) that the amount of ornithine plus arginine was fairly constant in cassava meal samples from the same botanical variety, whether they had been de-bittered or not

Our results suggest that a chemical reaction takes place, possibly due to the action of an arginase, during which urea is split off from arginine and hydrolysed to ammonia In more recent observations, which are to be published in greater detail elsewhere, similar investigations were made on samples from different botanical varieties A few of the results are given in table 2.

Table 2

Arginine and ornithine in samples of cassava
[mg per g crude protein (N x 5 8)]

Variety	Grown in	Arginine	Ornithine	Arginine + ornithine
Cassava rubona				
Sample 1 *not* de-bittered	Urundi	125 4	0 5	125 9
" 2 " "	"	120 7	6 0	126 7
" 3 soaked for de-bittering	"	120 8	0 6	121 4
" 4 "	"	43 6	82 4	126 0
" 5 "	"	124 0	7 7	131 7
Cassava nusurubya				
Sample 1 not de-bittered	Buyensi*	233 2	0	233 2
" 2 soaked for de-bittering	Bweru*	226 1	10 7	236 8
" 3 "	Mosso*	47 0	177 0	224 0

* Area in Urundi

It appears that the arginine content of fresh cassava roots differs in different varieties (and may prove to be a characteristic

sodium chloride solution and more concentrated solutions did not improve the yields, as much as 80 per cent of the salted out material might be dialysable We also found that the fraction soluble in 70 per cent alcohol varied from 20 per cent to 60 per cent and was usually completely dialysable, and that complete extraction of nitrogen was only achieved in many cases with the greatest difficulty

In nutrition studies, the total amino-acid content of the food is the important thing to determine, rather than the distribution of these acids in various breakdown products of fractionation based on differences in solubility in different conditions Moore and Stein's[8] chromatographic and quantitative method of determining amino-acids on columns of ion exchange synthetic resins has been used in this laboratory, in collaboration with Moore, to analyse acid hydrolysates obtained from complex natural media such as foodstuffs, without preliminary extraction of the protein material The method used and its justification are described in papers to be published shortly and have been reported in preliminary notes[3, 10]

Working with Close and Moore[5] we have applied this procedure to the study of cassava meal in which, in addition to the 18 amino-acids usually found in food proteins, we have found a large amount of ornithine Our quantitative determinations account for 84 2 per cent of the total nitrogen (ammonia nitrogen and humin nitrogen included) The cassava used was the bitter variety* and it was given the usual processing adopted by the local population for debittering, namely soaking in stagnant water, which results in hydrolysis of the cyanogenetic glucosides†

Expressed on a molar basis, the amino-acids were found in the relative proportions indicated in table 1

Table 1

Relative proportions of amino-acids on a molar basis (total = 100)

Analysis of a sample of de-bittered cassava meal from the Kwango (Belgian Congo)[5]

glutamic acid	18 8	threonine		3 8
ornithine	14 7	serine		3 8
alanine	11 1	isoleucine		3 2
aspartic acid	7 2	phenylalanine		2 9
glycine	6 7	proline		2 9
lysine	5 2**	tyrosine		1 9
leucine	4 8	histidine		1 7
valine	4 7	methionine	*ca*	1 4††
arginine	4 6	tryptophan		0 55
		cystine ½		0 5 (trace)

* In the Belgian Congo the bitter variety cassava is most commonly used for the production of cassava meal

† In French this process is known as 'le rouissage'

** Probably less

†† Probably a maximum figure

It was felt that the presence of ornithine in a foodstuff, particularly in such relatively large quantities and in a material of vegetable origin, required further investigation We were interested in finding out whether this unexpected constituent was present in the fresh cassava roots or appeared during the process of de-bittering[2]

It was found (a) that in non-processed roots there is only a small amount of free ammonia (ammonium salts), hardly any ornithine but a large proportion of arginine, (b) that in de-bittered material there is usually, though not always, a large amount of free ammonia, relatively large amounts of ornithine and very much less arginine, ornithine may also be found in preparations which have not been de-bittered by soaking but which have been dried in the sunshine in the open air for several days, (c) that the amount of ornithine plus arginine was fairly constant in cassava meal samples from the same botanical variety, whether they had been de-bittered or not

Our results suggest that a chemical reaction takes place, possibly due to the action of an arginase, during which urea is split off from arginine and hydrolysed to ammonia In more recent observations, which are to be published in greater detail elsewhere, similar investigations were made on samples from different botanical varieties A few of the results are given in table 2.

Table 2

Arginine and ornithine in samples of cassava
[mg per g crude protein (N x 5 8)]

Variety	Grown in	Arginine	Ornithine	Arginine + ornithine
Cassava rubona				
Sample 1 not de-bittered	Urundi	125 4	0 5	125 9
" 2 " "	"	120 7	6 0	126 7
" 3 soaked for de-bittering	"	120 8	0 6	121 4
" 4 "	"	43 6	82 4	126 0
" 5 "	"	124 0	7 7	131 7
Cassava nusurupya				
Sample 1 not de-bittered	Buyensi*	233 2	0	233 2
" 2 soaked for de-bittering	Bweru*	226 1	10 7	236 8
" 3 "	Mosso*	47 0	177 0	224 0

* Area in Urundi

It appears that the arginine content of fresh cassava roots differs in different varieties (and may prove to be a characteristic

of the variety), and that when ornithine is found in large quantities the amount of arginine is reduced in proportions which suggest that the ornithine has been mainly derived from it

What are the implications of these findings from the point of view of Africa's nutritional problems?

In cassava meal

(a) the nitrogenous material is proportionally rich in arginine (arginine + ornithine) which, on a molar basis, accounts for approximately one-fifth of the total amino-acids
(b) glutamic and aspartic acids represent one-fourth of the total on the same basis
(c) the eight essential amino-acids, according to Rose, make up about 23 per cent of all the amino-acids on a molar basis, whereas, according to the determinations made so far in our laboratory, the corresponding figure is of the order of 40 per cent or more for milk and meat proteins and of 30 per cent or a little more for cereal proteins
(d) the methionine content is very low and the traces of cystine are hardly sufficient to allow for reliable quantitative determinations

These findings may be of interest in the study of specific malnutrition problems such as those which are being closely examined at the present time in Central Africa, for example kwashiorkor

Although in an average adult man's diet with cassava meal as staple, a daily intake of three-quarters to one kilogram of this food alone is sufficient to cover entirely the calorie requirements, it will not provide more than 14 to 18 g of protein material of a poor biological value

On the other hand, it seems highly probable that the overall animal protein consumption cannot be expected to reach, on an average, a higher level than about 3 g daily per head of the Congo's native population The cassava meal ration for an adult mentioned above cannot be expected to supply more than 0 15 to 0 20 g of methionine daily Rose's[9] tentative estimate of the minimum requirement of this essential amino-acid for man corresponds to at least 1 1 g of methionine in the absence of cystine and according to Stare *et al*[12] the human adult requires daily 1 4 + 0 5 g of methionine + cystine Judging from these facts alone, it would seem justifiable to presume that the African breast fed child is probably very considerably deprived of the methyl donor constituents of its diet when it is taken away from its mother's breast and fed on a diet consisting predominantly of cassava meal In nutritional deficiencies characterized in their early stage of development by fatty infiltration of the liver, this important aspect of the problem in relation to the metabolism of lipotropic factors should be considered Yet it must be emphasized that from the nutritional and dietary point of view and judging from observations in the experimental field on animals, our knowledge of the metabolic processes involv

lipotropic factors available to the body must still be regarded as being rather scanty To feed patients suffering from kwashiorkor with methionine-enriched food is a therapeutic test that might be expected to give useful information on the pathogenesis of the condition

Although observations along these lines are desirable, one could hardly expect them to yield significant results unless they were integrated in a clinical and experimental programme of research of a wider scope in which the parts played by several other dietary factors were also studied Clear evidence has been given by du Vigneaud *et al* [6, 13] of the fact that choline can be formed by transmethylation, methionine acting as donor and amino-ethanol as acceptor of the methyl group Several observations, however, point to the existence of other substances also capable of playing a part as methyl transporters, namely the methylated amino-acids (betaines), and we do not know yet whether cassava meal contains such metabolites or not Another essential point concerns the catalytic mechanism which controls transmethylation There are indications that cyanocobalamin (vitamin B_{12}) may be involved in those biological processes

Obviously therapeutic tests should be so organized as to ensure (a) an adequate supply of suitable methyl donors, (b) the availability of suitable acceptors, and (c) the availability of the required catalytic agents, presumably cyanocobalamin if this alone is sufficient

No one of those three conditions may be expected to be sufficient by itself A deficiency condition might appear with an ample supply of methyl donors, the catalyst being unavailable or it might also be conceived to be due to a lack of donors, notwithstanding the availability of the catalyst As far as cyanocobalamin is concerned, its indigenous origin from the bacterial flora of the gut may be as important as its supply in adequate proportions from the diet There is, unfortunately, no available information on the eventual effect of parasitic infestation on the intestinal flora's ability to provide the host with cyanocobalamin, or about competition on the part of the parasites to consume cyanocobalamin

Finally, it should be borne in mind that preventive tests might eventually be efficient, whereas curative tests might fail to be helpful, wherever the pathological condition is liable to become rapidly irreversible

Large amounts of cystine are present in normal skin and hair, and in view of this, the possible relation between the extremely small amount of sulphur-containing amino-acids in cassava meal and the skin and hair symptoms of kwashiorkor, is worth mentioning.

We intend to investigate this point which seems to us to be of importance Whether or not cassava meal is rich in sulphur-containing substances other than methionine and cystine also needs to be investigated in connection with this last point

REFERENCES

1 Adriaens, E. L (1951) *Bull agric Congo belge*, 42, 227, 473

2 Bigwood, E J, Adriaens, E L & Medard, O (1952) *Arch int Physiol*, 60, 217

3 Bigwood, E J, Dustin, J P & Czajkovska, C (1952) *Arch int Physiol*, 60, 197

4 Bigwood, E J & Wodon, C (1952) *Arch int Physiol*, 60, 206

5 Close, J, Adriaens, E L, Moore, S & Bigwood, E J (1953) *Bull Soc Chim biol*, *Paris* *in press – see a preliminary communication* (1952) *Arch int Physiol*, 60, 198

6 Du Vigneaud, V, Chandler, J P, Simmonds, S, Moyer, A W & Cohn, M (1946) *J biol Chem* 164, 603

7 Kiger, J (1949) *C R du congres du manioc Institut Colonial, Marseilles, pp* 79–81

8 Moore, S & Stein, W H (1951) *J biol Chem*, 192, 663

9 Rose, W C (1949) *Fed Proc* 8, 546

10 Schram, E (1952) *Arch int Physiol* 60, 199

11 Sreeramamurthy, V V (1945) *Indian J med Res* 33, 229

12 Stare, F J, Hegsted, D M & McKibbin, J M (1945) *Annu Rev Biochem* 14, 431

13 Steensholt, G (1946) *Acta physiol scand* 11, 294

14 Van Veen, A G & Lanzing, J C (1941) *Geneesk Tijds* *Ind* 81, 2330

SULPHUR DEFICIENCY AND KWASHIORKOR

by

E. J. Bigwood

The sulphur-containing amino-acid methionine is known to be a choline precursor and to act in this capacity as a lipotropic factor Other methyl carriers, such as betaines, may be involved in the same physiological process and possibly cyanocobalamin (vitamin B_{12}) acts as catalyst in the process of transmethylation

One of the main pathological features of kwashiorkor is 'fatty liver', another is the involvement of hair and skin, tissues normally rich in the sulphur-containing amino-acid cystine * These facts suggest that the supply of sulphur may be of outstanding importance in the biochemical aspects of the disease

One of the research projects subsidized by the Institut pour promouvoir la Recherche Scientifique dans l'Industrie et l'Agriculture (IRSIA) in which our laboratory is taking part in Belgium is concerned with the influence of feeding-st ffs on meat and milk production (qualitative as well as quantitative) and, in this connection, we have been determining the amino-acid and total sulphur contents of various foods *In our research work for the Institut pour* la Recherche Scientifique de l'Afrique Centrale (IRSAC) we have made similar determinations on cassava meal (in collaboration with Adriaens and Schram - data not yet published) A few typical results are given in table 1

Table I

Sulphur content in mg per 100g of various products

	Cassava meal ('roui')	Barley	Hay	Linseed cake
Cystine S	3 3 (9 0)	63 (55 8)	25 (10 4)	168 (49 4)
Methionine S	4 3 (11 7)	32 (28 3)	25 (10 4)	77 (22 6)
Undetermined S (by difference)	29 1 (79 3)	18 (15.9)	190 (79 2)	95 (28 0)
Total	36 7 (100)	113 (100)	240 (100)	340 (100)

Figures in brackets indicate percentage of total sulphur

Total sulphur was determined by the method no 6-36 in 'Methods of Analysis of the Association of Official Agricultural Chemists', 7th edition, 1950

* Human hair contains 4 to 5 per cent sulphur keratins which form the basic organic material of skin and hair contain 11 to 12 per cent cystine (2 9 to 3.2 per cent sulphur) and in the adult man the skin represents about 6 to 8 per cent of the total body weight

The cystine and methionine sulphur were always found to account for only part of the whole, the remaining (undetermined) fraction varying from 16 per cent in a cereal such as barley to 79 per cent in hay and cassava meal. The nature of this fraction is now being studied, with special reference to inorganic sulphates and organic material such as betaines. It is apparent that, in comparison with some other products, cassava meal is not only particularly poor in cystine and methionine but is also low in total sulphur. What bearing might this have on man's sulphur requirements when cassava meal is the predominant item of the diet?

Little is known about sulphur requirements but the amounts supplied by typical dietaries can be compared and the role of certain foods as suppliers of the sulphur-containing amino-acids* can be assessed.

A typical West European type dietary at the 3,000 Calorie level, with about 100g proteins of mixed vegetable and animal origin, is usually considered to provide about 1g of sulphur from cystine and methionine alone. Three important foods within such a diet are wheat, meat and milk; table 2 shows very approximate amounts that might be consumed and the amounts of sulphur that would be supplied by them.

Table 2

Approximate supply of sulphur from three main items in a typical West European dietary

	Approximate Calorie value	Approximate sulphur content†
		g
Bread, 400g	1,000	0 45
Lean beef, 100g *22% crude protein* (N x 6 25)	150	0 21
Cow's milk, 500 ml	350	0 10
	1 500	0 76

* Cystine contains 26 7 per cent sulphur, methionine 21 5 per cent; the sulphur content of individual proteins ranges from 0 3 to over 3.0 per cent

† as we have no figures yet for wheat the value for bread is based on our findings for barley in which 0 38g out of the total 0 45g would be provided by cystine and methionine; the quantity of sulphur shown for beef and milk is the amount provided by cystine and methionine alone

In contrast with this, a 600g ration of cassava meal, supplying about 1,800 Calories, would provide only about 0 18g total sulphur of which only about 0 038g would come from cystine and methionine, a 900g ration (approximately 2,700 Calories) would provide a total of 0 33g, of which 0 068g would come from cystine and methionine

While it is true that a few other foods are eaten in addition to the cassava, the staple food in a typical African dietary supplies such a large proportion of the whole that additional items stand little chance of making good the gross deficiencies of the main dish It is therefore quite evident that in a typical African diet based on cassava the supply of sulphur to the body is only about one-third of the amount provided by a typical West European diet of similar calorie value

Now let us consider the African breast fed baby at one year of age, as it reaches - rather abruptly and perhaps prematurely - its weaning period.

The composition of the milk of African women, with particular regard to the sulphur supplied by cystine and methionine, is one of the subjects in the IRSAC Nutrition Section's programme of research (The data on mixed human milk produced in Belgium will be used for comparison - see Appendix)

Let us assume for the moment, notwithstanding the probability that the assumption is incorrect, that there is no difference between the milk of African and European mothers, and let us base our estimates of calorie requirements on European standards

Weight				Calorie requirements
At birth	3.5kg	120 per kg	=	420
At 6 months	7 0kg	110 per kg	=	770
At 2 years (average of 1 to 3 year range)	12.0kg			1,200

The curve based on these figures indicates a requirement of about 1,000 Calories at one year of age and to supply them from human milk 1 5 litres would be needed Our data indicate that this ration provides at least 0 13g of sulphur from cystine and methionine If at that age the child is taken from its mother's breast and receives cassava meal 'porridge', the amount required to give 1,000 Calories will supply only 0 02g of sulphur from cystine and methionine (an 85 per cent drop) or even less if a proper coefficient of digestibility were taken into account. The total sulphur supply will be of the order of 0 11g (0 0367 x 3) only a 15 per cent drop (disregarding the correction for a lowered digestibility coefficient) However, we do not know to what extent

the undetermined sulphur fraction is available to the body for protein synthesis in the infant and, particularly, for the building of keratin

This is the problem that needs further investigation Too abrupt a change from breast milk to a diet predominantly formed of cassava meal at too early a stage of the baby's life (one year of age) is accompanied by a marked drop in sulphur supply, whilst the building of tissue proteins, particularly those of the skin and hair, involves a high demand for sulphur IRSAC's research project is therefore taking into consideration the biochemical study of the milk of African women and of African skin and hair, both among normal subjects and those suffering from kwashiorkor

The data presented in this paper seem to justify the adoption of a sulphur deficiency as a working hypothesis The pathological condition under consideration involves many factors and the problem must not be oversimplified Whether a sulphur deficiency can also be traced in other areas where there are cases of kwashiorkor and where cassava meal is not necessarily the staple food, is a question open to debate

Although in some circumstances there may be a lack of sulphur in the diet, in others one may be dealing with a conditioned deficiency, that is, a defect in absorption from the gut Therefore, sulphur balances should be studied as well as nitrogen and fat balances

The little we know about the metabolism of skin and hair suggests that properly balanced amino-acid supplies must be made available to these tissues to ensure their normal healthy development Jacquot's[1,2] investigations on rats seem to support such views

It appears that more information is needed on the biochemistry of the skin and hair both in normal and in weaning dystrophy states, in both white and black races, and particularly in relation to the cystine content of these tissues and to the total sulphur total nitrogen ratio Such information might even throw light on the reasons why the skin plays a conspicuous part in pathology in general throughout the African continent

APPENDIX

The data upon which the paper is based were obtained in the writer's biochemical laboratory in collaboration with a group of co-workers*

	100g meat (lean meat) 22% 'crude' protein	100g milk proteins (N x 6 25) a human milk b cow's milk	
Calories	150		
Cystine, g	0 28	a	1 5
		b	0 8
Cystine S, g	0 075	a	0 400
		b	0 214
Methionine, g	0 64	a	≥ 1.7
		b	2 1
Methionine S, g	0 138	a	≥ 0 365
		b	0 452
Total sulphur, g	0 213	a	≥ 0 765
		b	0 666

Analysis of mixed human milk samples collected in Belgium indicated that 1 litre would yield 650 Calories and contained at least 0 084g sulphur compared with 0 2g from 1 litre of cow's milk (mixed samples analysed in our laboratory) Complete analysis of a sample of the bitter variety of cassava meal after the native de-bittering process ('rouissage') showed that 100g (equivalent to about 300 Calories) contained 0 0367g total sulphur This value is not presented as a representative average Several varieties are being analysed in our laboratory by Mr E L Adriaens, and a fairly wide range of figures has been obtained The data indicate that non de-bittered material may contain definitely more total sulphur than the corresponding de-bittered preparation Our investigation has not yet reached the stage allowing us to state definite conclusions, the figure presented here is rather high

REFERENCES

1 Jacquot, R & Mahadevan, V (1950) *Ann Nutr Paris* 4, 561

2 Jacquot, R & Mahadevan, V (1950) *Arch Sci physiol* 4, 379

* S. Moore (Rockefeller Institute for Medical Research, New York) J P Dustin R Crokaert P Soupart, E Schram J Close E. L. Adriaens, O Medard, C Czajkowska Cl Wodon G Baur, R Bronchart and E. Bilinski

RESULTS OF FEEDING ANIMAL PROTEIN FACTOR CONCENTRATE TO GAMBIAN SCHOOL CHILDREN

by

B. S. Platt and M. W Grant

Administration of cyanocobalanin (vitamin B_{12}) has been shown to have no effect on the growth rate of either normal[3] or underweight[1] children in the south of England, their diet was, however, unlikely to be deficient in this nutrient It was thought that it might have an effect on the growth of children in a community whose diet contained a minimum of animal protein

Children on a typical Gambian diet (page 225) receive after weaning little or no milk, no eggs and only small and irregular supplies of meat or fish Marked seasonal fluctuations take place in both quantity and quality and, in many districts, the 'hungry season' is severe enough not merely to check growth but actually to cause a fall in body weight among children as well as adults[2] In these circumstances, there might well be a dietary shortage of cyanocobalamin, or 'animal protein factor' (APF), which is believed to contain cyanocobalamin and an antibiotic

Administrative difficulties made it impracticable to have test and control groups at the same school, and the small size of the schools made it necessary to include all the pupils, irrespective of age Two schools were therefore chosen, at the one selected as the test school there were 42 boys and 3 girls with an age range of 5 to 14 years, and at the control school there were 51 boys and 3 girls with an age range of 6 to 15 years

A Fuller's earth adsorbate* containing 13 4 µg APF per gram was used for the test It was made up in Manucol† and water, sweetened with saccharine, coloured with carmine and flavoured with peppermint Each child in the test group received 15ml (equivalent to 1g adsorbate) on each school day between July 1951 and June 1952 The children were weighed at fortnightly intervals during the terms and heights were measured at monthly intervals The children at the control school were also weighed every fortnight but their heights were measured at irregular intervals Attendances were not very good, though better in the test group than in the control, and several children left in the course of the year

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* Kindly supplied by Glaxo Laboratories Ltd , London

† Brand of sodium alginate manufactured by Albright & Wilson Ltd. London

Table 1 sets out the average change in height and weight for those children (all boys) who were present at both first and last measurings Although height gains in different groups may be compared directly, weight gains need to be compared on the basis of percentage increments and not actual increases This is because, while growth in height is linear, growth in weight is logarithmic in nature and the heavier the initial weight, the greater the expected gain - up to the point at which the growth curve flattens out with the approach of maturity

Table I

Analysis of height and weight measurements of children given APF and control subjects

	Test group		Controls	
Weight changes				
Number in group	26		35	
Period (weeks)	49		48	
	lb	kg	lb	kg
Mean weight in July 1951	73 72	33 4.	68 11	30 89
" " " June 1952	79 73	36 17	73 98	33 56
Difference	6 01	2 73	5 87	2 66
" as percentage of initial weight	8 15		8 60	
height changes				
Number in group	28		26	
Period (weeks)	45		46	
	in	cm	in	cm
Mean height in July 1951	55.08	139 9	53 21	135 2
" " " May 1952	56 44	143 4	54 63	138 8
Difference	1 36	3 5	1 42	3 6

Comparisons on this basis show that, for both height and weight, the group of children receiving the APF supplement grew more slowly than those in the control group Such differences could, however, be a result of differing bias in the age scatter within the two groups

In some communities, growth appears to be slow over the age range 8 to 12 years and to speed up at the onset of puberty (the 'puberty spurt') Brody believes that this is, in itself, a sign of malnutrition and that in a well-nourished community the rate of gain in weight approximates to 10 per cent per annum over the whole range of 5 to 15 years Where the first of these two conditions prevails, it is necessary to examine the material in detail to make

sure that a greater mean gain by one group is not merely due to a greater number of individuals at the 'puberty spurt' level

Where births are not registered, ages tend to be uncertain, and although in these two schools children claimed to know their ages, the evidence suggests that, at least in the test school, there may have been a considerable margin of error The graphs show the mean heights and weights for claimed ages, at one-yearly intervals, compared with the averages for London County Council children in 1949[5] The actual values are set out in table 2

Table 2

Heights and weights for treated children and controls, grouped according to age

Central age (years)	Test group					Control group				
	No	Height in	Height cm	Weight lb	Weight kg	No	Height in	Height cm	Weight lb	Weight kg
5½	1	47 50	120 7	51 00	23 13					
6½	4	51 56	131 0	56 80	25.76	2	45 25	114 9	43 25	19 61
7½	6	52 04	132 2	59 58	27 02	7	48 68	123 6	49 57	22 48
8½	4	50 88	129 2	57 12	25 91	8	51 00	129 5	53 81	24 41
9½	10	52 05	132 2	59 00	26 76	7	51 14	129 9	58 86	26 70
10½	6	56 54	143 6	71 04	32 22	5	54 05	137 3	65.60	29 76
11½	1	54 25	137 8	67 00	30 39	2	54 75	139 1	69 75	31 64
12½	5	59 30	150 6	90 40	41 01	4	57 94	147 2	79 12	35.89
13½	4	60 81	154 5	90 94	41 25	3	57 08	145 0	80 33	36 44
14½	3	66 67	169 3	109 42	49 63	3	64 17	163 0	111 17	50 43
15½						3	64 75	164 5	121 83	55 26

The numbers in each age group are, of course, far too small to yield true averages for the community but, even so, the test group figures suggest age errors whereas the control group graph is consistent with annual increments of 8 to 9 per cent in weight and something less than two inches in height

Individual weight increments in the two groups showed a big variation (1 6 to 18 1 per cent in the test group and 3 0 to 15 8 per cent in the control) but no tendency for the higher figures to correlate with higher initial weights, so that the presence of a 'puberty spurt' bias in either group seems unlikely

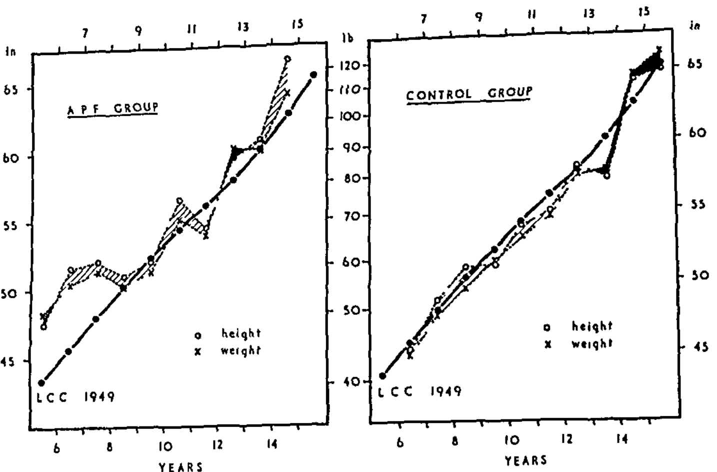


Fig 1 Heights and weights by stated age of Gambian boys, 1951-2

In view of seasonal variation in the rate of growth, gains made in an eleven month period cannot be used as any indication of annual gains The remaining month (two months in the case of the height recording in this experiment) may see either a spurt or a retardation Very few children were weighed often enough to provide reliable evidence of the seasonal growth pattern The data available are set out in table 3

Table 3

Seasonal pattern of weight gains

Test group					Control group			
Number in group - 17					Number in group - 14			
		Weeks	lb	kg		Weeks	lb	kg
1	July - Sept	8	-0 91	-0 41	July - Sept	8	+0 48	+0 22
2	Sept - Oct	6	+0 53	+0 24	Sept - Oct	6	+1 05	+0 48
3.	Oct - Dec	8	+1 41	+0 64	Oct - Dec	7	+0 68	+0 31
4	Dec - Jan	5	+1 09	+0 49	Dec - Jan	6	+1 79	+0 81
5	Jan. - Mar	8	+0 72	+0 33	Jan - Mar	8	+0 84	+0 38
6	Mar - Apr	4	+0 25	+0 11	Mar - May	9	+0 34	+0 15
7	Apr - May	6	+0 82	+0 37	May - June	4	+0 59	+0 27
	May - June	4	+0 97	+0 44				
Mean initial weight			63 74	28 91	Mean initial weight		66 35	30 10
Total gain (49 weeks)			4 88	2 21	Total gain (48 weeks)		5 77	2 61
Percentage increment			7 6		Percentage increment		8 7	

In the test group, the periods alternate between 'with supplement' and 'without supplement', beginning with a period of APF administration

These figures make it apparent that the seasonal pattern of weight gain was not the same in the two groups and cast doubt on the validity of the second school as a suitable control for the first The difference shows up more clearly in the graphs which set out the cumulative weight gains over successive periods

As the numbers in these constant groups were small enough to be biased by one or two abnormal individuals within the groups, it was necessary to seek confirmation of this difference in seasonal pattern Accordingly, each two consecutive weighings were treated as a separate entity and the records of all children present on both occasions were analysed to show the proportion gaining, losing or remaining steady in weight In this way the behaviour of larger

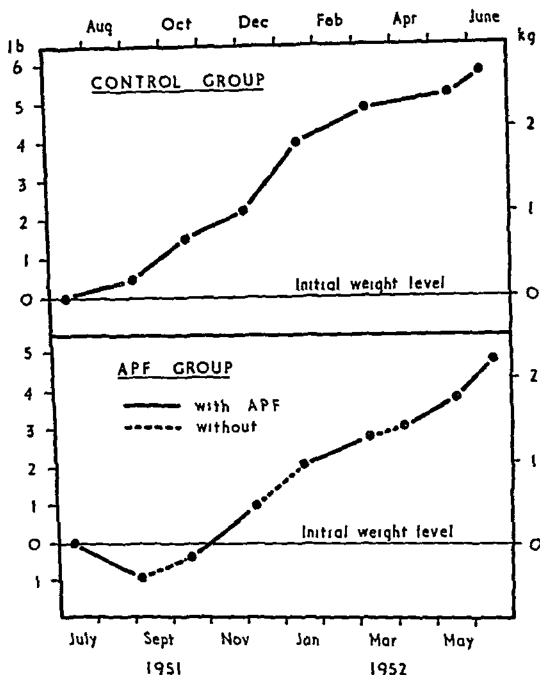


Fig 2 Seasonal pattern of weight gain in the two groups of Gambian boys

groups could be studied and although these groups changed slightly in composition in the course of the year, the changes were small, the same individuals recurred time and time again and all these sub-groups were drawn from the same main group

Table 4 sets out the results of this analysis and confirms the seasonal trends of the two smaller constant groups It is clear that the test group children were handicapped by an initial loss of weight which had to be restored before they could add to their initial level. The fact that, over the eleven month period, their total gain was 8 15 per cent as against the control group's 8.60 per cent suggests that their rate of gain, once the initial loss had been made good, must have been considerably greater than that of the controls, whose annual gain was spread over the whole period.

Table 4

Seasonal trends of weight gains (changing groups)

Period	Numbers concerned				Mean change in weight	
	Total	Gains	Losses	Steady	lb	kg
Test group						
July - Sept	30	10	20	0	-0 79	-0 36
Sept - Oct	36	20	13	3	+0 61	+0 28
Oct - Dec	35	32	3	0	+1 53	+0 69
Dec - Jan.	36	30	5	1	+1 46	+0.66
Jan - Mar	37	28	7	2	+1 02	+0 46
Mar - Apr	38	20	12	6	+0 21	+0 10
Apr - May	36	31	2	3	+1 12	+0 51
May - June	30	25	5	0	+0 83	+0 38
Control group						
July - Sept	30	16	11	3	+0 56	+0 25
Sept - Oct	23	18	2	3	+0 91	+0 41
Oct - Dec	30	18	2	10	+0 34	+0 15
Dec - Jan	38	26	8	4	+1 06	+0 48
Jan - Mar	37	28	4	5	+1 48	+0 67
Mar - May	33	21	8	4	+0 65	+0 29
May - June	30	22	4	4	+0 68	+0 31

An analysis of the gains made between October and June gave the differences shown in table 5

Table 5

Weight gains between October and June

	Test group		Control group	
Number of boys	31		28	
Period (weeks)	35		34	
	lb	kg	lb	kg
Mean initial weight	71 19	32 29	72 49	32 88
Total gain	6 01	2 73	4 28	1 94

The question then arises as to whether the children in the test group would have been able to do so well in the absence of the APF supplement Although they received it in the first period – when weight was lost – this was the 'hungry season' and the supplement could hardly be effective if the calorie supply was grossly inadequate

The only figures available for comparison are those of the Mandingo boys in Yoro Beri Kunde[2] This small group (ten only) also lost weight during the hungry season, yet their gain in the hole year was 8 8 per cent of their initial weight In figure 1 the growth curve – despite its unevenness – also suggests that the usual annual gain must be of this order and not greatly less than 8 per cent

It appears, therefore, that dosage with APF made little or no difference* to the growth rates of the children to whom it was administered

REFERENCES

1 Administration of vitamin B_{12} to underweight children, *Middlesex County Council (unpublished)*

2 Applied Nutrition Unit, London School of Hygiene and Tropical Medicine *A Nutrition Survey in Yoro Beri Kunde, Gambia (unpublished)*

3 Benjamin, B & Pirrie, G D *(1952) Med Offr,* 87, 137

4 Brody, S. *(1945) Bioenergetics of Growth, Reinhold, New York*

5 Report on the Heights and Weights of School Pupils in the County of London in 1949. *(1950) London County Council*

*(1952) The Director of the Institute of Central America and Panama (INCAP) reports that in field trials in El Salvador and Guatemala, no effects of cyanocobalamin or aureomycin were observed during feeding trials extending over one year

Table 4 sets out the results of this analysis and confirms the seasonal trends of the two smaller constant groups It is clear that the test group children were handicapped by an initial loss of weight which had to be restored before they could add to their initial level The fact that, over the eleven month period, their total gain was 8 15 per cent as against the control group's 8.60 per cent suggests that their rate of gain, once the initial loss had been made good, must have been considerably greater than that of the controls, whose annual gain was spread over the whole period

Table 4

Seasonal trends of weight gains (changing groups)

Period	Numbers concerned				Mean change in weight	
	Total	Gains	Losses	Steady	lb	kg
Test group						
July - Sept	30	10	20	0	-0 79	-0 36
Sept - Oct	36	20	13	3	+0 61	+0 28
Oct - Dec	35	32	3	0	+1 53	+0 69
Dec - Jan.	36	30	5	1	+1 46	+0 66
Jan - Mar	37	28	7	2	+1 02	+0 46
Mar - Apr	38	20	12	6	+0 21	+0 10
Apr - May	36	31	2	3	+1 12	+0 51
May - June	30	25	5	0	+0 83	+0 38
Control group						
July - Sept	30	16	11	3	+0 56	+0 25
Sept. - Oct	23	18	2	3	+0 91	+0 41
Oct. - Dec	30	18	2	10	+0 34	+0 15
Dec - Jan	38	26	8	4	+1 06	+0 48
Jan - Mar	37	28	4	5	+1 48	+0 67
Mar - May	33	21	8	4	+0 65	+0 29
May - June	30	22	4	4	+0 68	+0 31

An analysis of the gains made between October and June gave the differences shown in table 5

the baobab *(Adansonia digitata)*, cassava and sweet potato *(Ibonoea botatus)* leaves, okra *(Hibiscus esculentus)* leaves, and the okra fruit itself

Fruit consumption is low, mainly plantains and bananas* *(Musa spp)* eaten fried, boiled or roasted, or dried and beaten into a flour Oranges *(Citrus spp)*, mangoes *(Mangifera spp)* and pawpaws *(Carica papaya)* may be eaten in season

Meat and fish Cattle meat is expensive as the animals are mostly driven from the Northern Provinces and are therefore lean Goats and sheep are kept but are eaten chiefly on ceremonial occasions Large snails are eaten In remote areas, meat consists mostly of small game such as squirrels, bush-rats, and small deer, shot or trapped and sold raw, smoked or dried Fish is eaten on the coast, some smoked fish is sold in the interior at a high price Freshwater fish is sometimes obtained inland

<u>efo</u> a stew, eaten with gari, foo-foo or yam Meat or fish is cut into small cubes and fried in palm oil, leafy vegetables (washed sometimes boiled) are added with water, pounded melon *(egusi)* seeds, plenty of peppers, and a little onion and salt The stew is cooked in an earthenware or iron pot over an open fire

Oils Palm oil extracted from the fibrous pericarp of the oil palm *(Elaeis guineensis)* is the main oil used for cooking, it is a reddish colour and has a high carotene content A whitish oil is made from the kernel Other oils, less extensively used, are made from groundnut, coconut and melon seed

Palm wine chief alcoholic beverage, made from the sap of the oil palm an important source of the B-group of vitamins

DIETARY PATTERN

The number of meals varies between one and three Children may leave home for school with little or no breakfast and may be given a penny or halfpenny to buy lunch (which may be only an akara ball, about the size of a billiard ball) They return home, after a listless day at school, to eat at 3 p m The worst sufferers are children of broken homes living with one parent who may be out all day There is a local prejudice against the eating of meat and eggs by children, as it is thought that these foods make them lazy and in some cases they are thought to be injurious to health

Meals of the working class are

Breakfast	pap, ogi or gari, and a little akara
Midday	gari, cooked yams or sweet potatoes, and a little moin-moin (working men, however, buy from itinerant hawkers their midday meal, which is usually insubstantial)

* see footnote to page 310

FOODS OF WESTERN NIGERIA

by

Davidson Nicol

NAMES, PRODUCTS AND METHODS OF PREPARATION

Maize *(Zea mays)* Eaten boiled or parched, or used as a flour

<u>ogi</u> maize is soaked for a few days, washed and drained The corn is pounded, and extracted by draining and re-washing several times with the same water The thick white sediment is ogi this can be made with boiling water into a gruel of medium consistency

<u>eko</u> a stiff porridge made from ogi, eaten with soup or <u>akara</u>

Rice *(Oryza sativa)* Usually boiled with soup or made into pap (sometimes fed to infants) More rarely made into pudding or pancakes Too expensive for most people

Cassava *(Manihot utilissima)* Eaten boiled, fresh and sliced, or dried and grated into a coarse flour from which are made roasted cakes and biscuits

<u>gari</u> cassava tuber is peeled, washed and grated into a wet pulp which is drained in a weighted sack and fermented for two to four days, when it is considered ripe After sifting, the residue is parched in an iron pot Eaten in this form, or soaked with cold water when sugar and milk are sometimes added

<u>ebba</u> gari is poured into boiling water the swollen starch grains make a thick cohesive paste which is eaten with soup (<u>efo</u>)

<u>foo-foo</u> ripe cassava tubers are soaked in water for four days, and grated and drained for three days The pulp is ground, soaked and sieved then boiled, whilst slowly stirred, in an iron pot

Yam *(Dioscorea* spp *)* Boiled, alone or with a variable mixture of leaves, palm oil dried fish peppers, etc , or ground and made into cakes for roasting and frying. The main food from November to March

<u>amala</u> flour from raw dried yam, ground and made into a paste

<u>foo-foo</u> prepared similarly to that from cassava, fermented and eaten with soup

Beans Eaten especially during the 'hungry season' (March to October)

<u>akara</u> (fried cake) skinned and well-washed beans are ground on a flat clean stone and mixed with water, salt and pepper The mixture is made into lumps with a spoon and dropped into boiling oil for a few minutes

<u>moin-moin</u> (boiled cake) prepared as for akara, then a little palm oil is added and the mixture is tied into plantain leaves and boiled

Vegetables, especially green leaves, are important ingredients of stews used fresh or dried Wide variety including leaves of

the baobab *(Adansonia digitata)*, cassava and sweet potato *(Ipomoea batatus)* leaves, okra *(Hibiscus esculentus)* leaves, and the okra fruit itself

Fruit consumption is low, mainly plantains and bananas* *(Musa spp)* eaten fried, boiled or roasted, or dried and beaten into a flour Oranges *(Citrus spp)*, mangoes *(Mangifera spp)* and pawpaws *(Carica papaya)* may be eaten in season

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* see footnote to page 310

Evening beans and palm oil only, or gari, rice or yams with efo A few ounces of meat per week are eaten, usually with the evening meal

During the long intervals between meals, adults chew kola nuts *(Cola acuminata* and *Garcinia kola)*, sugar cane *(Saccharum officinarum* or awusa nuts *(Tetracarpidium conophorium)* as stimulants or snacks

The middle class have a similar diet to that of the poorer people but it is of better quality and greater quantity and includes soup (with more meat or fish in it) at midday and in the evening They may also have tea, coffee or cocoa with a little condensed milk

The wealthier people have a full and varied diet, usually a mixture of African and European dishes

The following European foods have been adopted by some groups, polished rice and corned beef, or biscuits and sardines and tea

DEMONSTRATION OF GAMBIAN FOODS

by members of the staff of

the MRC Field Research Station, Fajara

Descriptions of these foods are given in 'The Useful Plants of West Africa' by J M Dalziel (1937) published by the Crown Agents for the Colonies The numbers in brackets after the food names are the pages on which descriptions may be found

Cereals

Rice *(Oryza sativa)* (533) - two varieties of local grain, in husks Samples of whole grain after first pounding
<u>Denpentingo</u> - new rice after parching, pounding and cooking in the fields
Coos, in whole head - bulrush millet *(Pennisetum* spp) (538) <u>sanyo</u> - main crop, and <u>suno</u> - early millet Sorghum *(Sorghum gambicum)* (547) <u>kinto</u> - red, and <u>basso</u> - white
Findo *(Digitaria exilis)* (526) - whole grain, and sample after first pounding

Root

Cassava *(Manihot utilissima)* (150) - raw, fermented and as flour

Oil, oil seeds and nuts

Palm *(Elaeis guineensis)* (499) - whole fruit kernels and oil
Groundnut *(Arachis hypogaea)* (228) - nuts and paste
Kola nut *(Garcinia kola* and *Cola acuminata)* (91 and 100)

Vegetables

Peppers *(Capsicum* spp) (427) - eight varieties
Baobab *(Adansonia digitata)* (112) - leaves, fresh, dried and powdered, and fruit ('monkey bread')
Locust beans *(Parkia* spp) (218) - fresh and fermented (tolingo)
Garden egg *(Solanum* spp) (433)
Shallots *(Allium ascolonicum)* (484)
Sour-sour leaves *(Hibiscus sabdariffa)* (129)
Spinach *(Amaranthus* spp) (35)
Tomatoes *(Lycopersicum esculentum)* (430) and bitter tomatoes

Fish

Dried salted and dried smoked

THE DIET OF THE RURAL BASUTO*

by

K E A Underwood Ground

FOODS - THEIR NAMES, PRODUCTS AND METHODS OF PREPARATION

Main or staple foods

Maize *(poone) Zea mays*
Maize meal (mealie meal) - formerly home-ground, now almost all machine-milled

	Whole ground†		Refined	
	g/lb	g/kg	g/lb	g/kg
Protein	41 8	92 2	35 9	79 1
Fat	17 7	39 0	5 4	11 9
Carbohydrate	335 0	738 5	336 0	740 7
	mg/lb	mg/kg	mg/lb	mg/kg
Thiamine	1 74	3 84	0 61	1 34
Riboflavin	0 5	1 1	0 21	0 46
Nicotinic acid	9 1	20 1	4 7	10 4
	No vitamin C or D			

* See Report of the Committee on Nutrition in the Colonial Empire (1939) Cmd 6051, part II, page 49 in which reference is made to a report on this subject by Mr Hugh Ashton

† Produced by hammer mills

'Dishes'

lesheleshele a soft porridge One cupful mealie meal added to one pint (0 57 litres) boiling water, stirred periodically while simmered for half-an-hour Eaten with a spoon, or sometimes, when more water is added, drunk from cup or mug

papa mealie meal pap Mealie meal is added to boiling water until thick, cooked for an hour-and-a-half Consistency of bread eaten with spoon or fingers, mainly by the men, who do not eat soft porridge (lesheleshele)

motoho sour porridge, made from home-ground mealie meal (see 'Beverages')

bohobe a bread made by steaming mealie meal dough

setampo samp Whole maize softened in water, then dried and crushed When required for eating, boiled in water, used thick or thin Eaten with meat when available

likhobe dried whole maize Boiled till soft, peeled and eaten when cold

lipabi dried whole maize Roasted until brownish When cold, ground with salt and sugar Eaten occasionally Fresh or green mealies - corn-on-the-cob Boiled or roasted

Kaffir corn *(mabele) Sorghum vulgare* Eaten as a thin gruel (lesheleshele) mainly by young mothers, or as a thick porridge, mostly by women

Kaffir corn is more expensive (4½d per lb) than mealie meal (3d per lb) and though sometimes used for bread, is used extensively for making beer (see 'Beverages') Many men live on beer and meat only

Wheat *(koro) Triticum vulgare* Used mostly in the mountain areas, almost exclusively for making bread (bohobe), and occasionally for beer Beer is used to make the bread rise

Oats *(lierekis) Avena sativa* Grown for feeding stock only

Foods used in preparation of side-dishes or eaten as 'snacks'

Vegetables Cabbage, carrots - grown fairly commonly Wild green leaves (spinaches) - many varieties

Legumes Beans *(linaoa) Phaseolus vulgare* and field peas *Pisum sativum* - eaten fresh or dried Cowpeas *Vigna unguiculata* - a small amount grown in the south

Stalk Sweet sorghum *(ntsoe) Sorghum saccharatum*

Fruit Peaches - eaten fresh or dried - most families have a peach tree Apricots Tomatoes - not commonly eaten - bought from shops

Cucurbits Pumpkins - both hard and soft skinned varieties, grown by nearly all families Water melons

Meat Poultry - usually boiled and eaten with mealie meal Mutton Beef - eaten fresh or as biltong *(lihaoba)* Pork - boiled or fried Horse - eaten sometimes

Fish Rarely, if ever, eaten

Insects and larvae Not generally eaten, herd-boys sometimes eat roasted grasshoppers

Beverages

Beer *(joala)* Kaffir corn is ground to a rough meal which is damped and added to boiling water *Moroko* (remains of strained beer) is added The mixture is left overnight, and next morning is reboiled and left to cool *Tela** is added and the thickened mixture is covered and left for 24 hours, then strained

Motoho Dry mealies are ground to a rough meal which is damped with water, left for six hours, then ground to a fine meal It is then further diluted and, with a small quantity of some previously prepared motoho, is added to boiling water The mixture is covered and left overnight, and is ready for drinking next morning

Mahleu mealie meal boiled in water

Milk fresh or sour *(mafi)*

FEATURES OF DIETARIES OF MEN, WOMEN AND CHILDREN IN LOWLAND AND MOUNTAIN AREAS AT DIFFERENT TIMES OF YEAR

Lowland areas - men

Spring (September and October)

<u>Basic foods</u> Mealie (maize) meal as hard porridge *(papa)*, soft porridge *(motoho)* or bread *(bohobe)* Mealie meal in a drink *(mahleu)* Stamped maize Mill-ground wheat if obtainable, baked as bread *(bohobe)* - eaten to a lesser extent Kaffir corn *(mabele)* meal eaten as stiff porridge Dried peas and beans - boiled, eaten occasionally

<u>Protective foods</u> Meat - very occasionally, when a beast dies (and therefore more meat eaten in times of severe drought than at other times) Mutton - from mountain sheep - is expensive and is bought from butcher Milk and eggs - very occasionally Oranges - largely bought Pigweed - collected by women and boiled *(thepe)*

<u>Fermented liquids</u> Kaffir beer *(joala)* made from fermented Kaffir corn daily when possible

Summer (November to March) and **Autumn** (April and May)

<u>Basic foods</u> Mealie meal and wheat as in Spring Green mealies - roasted or boiled Pumpkins Potatoes and dried beans occasionally

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* Kaffir corn soaked in water for four to seven days then laid out on the ground in the sun and covered with sacks When germination starts uncovered and sun-dried

Protective foods Meat and eggs as in Spring More milk available but still not plentiful Water melons Peaches Small amounts of cabbage, carrots and onions Wild spinach *(moroho)* - is not often eaten by men
Fermented liquids Kaffir beer, as in Spring

Winter (June to August)
Basic foods Mealie meal and wheat as in Spring Home-made samp *(likhobe)* prepared from mealies boiled, and beans boiled Beans often added to samp
Protective foods Meat and eggs as in Spring Very little milk Condensed milk - used, when available, by the more wealthy people Tea - common, usually taken with milk and sugar No green vegetables
Fermented liquids Kaffir beer as in Spring

Lowland areas - women and children

The diet of women and children is the same as that of the men, with the following exceptions

If obtainable, milled Kaffir corn *(mabele)* is eaten as a soft porridge *(lesheleshele)* This is particularly so in the case of pregnant women *(Lesheleshele* is seldom eaten by men)

It is against the Basuto custom for children to eat eggs

Wild spinach *(moroho)* is usually eaten daily, in the boiled form, in Spring if the rains come early, and in Summer and Autumn

Wild berries *(monokotsoai)* are eaten by children in the Summer but are not plentiful

Mountain areas

As the diets of the men, women and children are practically identical, they are listed together The remarks concerning eggs and wild spinach in the lowland areas apply to the mountain areas also

Winter and **Spring** (June to October)
Basic foods Mealie meal is a luxury and is eaten when funds allow (mealies are not grown in mountain areas - mealie meal is twice the price of wheat) Home-grown wheat - ground on the stone - baked as bread Very little Kaffir corn grown - expensive to buy Dried peas eaten fairly frequently
Protective foods Meat - normal family eats mutton two or three times a week Milk more plentiful than in the lowlands but cattle often grazed far from villages Eggs eaten very occasionally
Fermented liquids Beer made of fermented wheat and mealie meal *(joala)*

Summer and Autumn (November to May)

Basic foods As in Winter and Spring, with the addition of potatoes

Protective foods Meat - mutton - not so much available during the period of wool growth, killings are more frequent after sheep-shearing in January Very little beef eaten Milk much more plentiful, drunk fresh or as 'thick milk' *(mafi)* Wild spinach plentiful Small amounts of cabbage, carrots and onions Few water melons and peaches

Fermented liquids Beer, as in Winter and Spring.

Foodstuffs from Bechuanaland were exhibited by B T Squires The diet of the Tswana is described in a paper by Dr Squires on page 6

FOODS FROM SOUTHERN RHODESIA

by

E Baker Jones

A number of foods from Southern Rhodesia were shown, also a series of photographs illustrating methods of storage of foods Since the Conference coincided with the end of the dry season in Southern Rhodesia, the 'relish' foods were scarce and it was of interest that according to Dr Baker Jones, the specimens of dried green goods could have been just as readily obtained in the market at Bathurst Gambia

White maize is the staple food of Southern Rhodesia, it is supplemented by bulrush millet *(Pennisetum typhoideum)* finger millet *(Eleusine coracana)* sorghum and upland rice The climate of the south-western province of Matabeleland is particularly suitable for sorghum production, which is greater in this area than in the whole of the remainder of Southern Rhodesia In urban areas there has been an increase in the consumption of sugar and of bread made from refined wheat flour As both sugar and wheat flour have to be imported, the increasing demand is becoming embarrassing

The main traditional dish consists of a stiff porridge prepared from the milled staple cereal by lightly boiling. The porridge is eaten with a relish or side-dish, the nature of which varies Those commonly used are boiled, sun-dried green leaves, e g rape spinach, pumpkin and bean, or cooked green vegetables such as okra, flavoured with salt and a sauce made from cooked, pounded groundnuts A favourite relish has as its main ingredient certain wild fungi Beans served in the water in which they are cooked is another popular side-dish

Some foodstuffs, animal products including meat, termites and caterpillars (the two latter fried in their own fat), also sweet potatoes and pumpkins, are served as snacks rather than relishes or side-dishes The relish or side-dish differs from a snack in that the former is an essential accompaniment of the porridge, assisting in deglutition whereas the latter is regarded as rather a luxury When the thick porridge is eaten it is rolled into a ball with the fingers of one hand, dipped into the relish and swallowed whole without mastication, hence the importance of the relish for lubrication of the bolus Snacks are eaten by themselves at odd times and are properly masticated

Judged by European tastes, the cereal dishes are too lightly cooked vegetables, on the other hand, whether tough or not, are, by the same standards, overcooked

Native beer is brewed from maize and finger millet

Small, almost negligible, amounts of cow's and goat's milk are consumed Infants are fed from an early age with cereal pap and as a rule they are weaned late

The average daily consumption of beef is less than ¾ oz (21g) per head other animal products are consumed in much smaller amounts Poultry are reared for sale in the European market and eggs are regarded as potential chickens rather than as articles of diet

The bulk of the legume crops is sold for cash Oil and margarine are produced from most of the groundnuts grown and the residue is used for cattle cake

Experiments are being made on fish-farming, it is hoped that eventually fish may be available for improving the African diet

Photographs were exhibited showing winnowing of grain by a process which was the same as that demonstrated by the Gambian women at the Conference (frontispiece) The grain after soaking is milled by rubbing it on a large flat stone with a smaller stone with a flattened surface, in a manner similar to that used for producing *masa* in Mexico where, however, the grain is soaked for a longer time and the product of stone-milling is cooked differently

Photographs illustrating typical food stores in the native reserves were exhibited As weights and measures are not in general use, calculations of food stores are judged by experience

The main dietetic diseases seen in Southern Rhodesia are, in order of frequency of occurrence pellagra, kwashiorkor, ariboflavinosis, scurvy, night-blindness and other eye and skin changes associated with vitamin A deficiency, anaemia (almost always microcytic) and endemic goitre as no detailed surveys have as yet been made, there is no accurate knowledge of incidence and distribution

Attempts to improve the diet of the African in Southern Rhodesia are being made by the introduction of two new dishes, one a maize tortilla traditional in Mexico, and *tempe* as produced in Indonesia Difficulties have arisen in the preparation of *tempe* as the air temperature and humidity in Southern Rhodesia are not favourable for the fermentation processes, and plant and equipment will have to be designed for this purpose

The method used for preparation of *tempe* is given on page 278 It is of interest that farmers of Southern Rhodesia have been attracted by *tempé* as a feed for cattle and it is as such that it may first appear on the market It is thought that the artificial heat and humidity of the tobacco curing sheds of Southern Rhodesia might be adapted to the manufacture of *tempe* and it seems that the production of soya bean, the advantages of which have been so advocated by Southern Rhodesian agriculturalists, may be stimulated by a demand for *tempe*, in the first instance for feeding cattle

FERMENTED FOODSTUFFS IN USE IN VARIOUS PARTS OF THE WORLD

by

B S Platt

This memorandum is based on material gathered together early in 1941, since this memorandum was prepared there have been several publications which may be of interest[1 3 6 7]

Numerous foodstuffs and beverages are fermented at some stage in their preparation The practice is common and widespread and its importance lies in the probable contribution of micro-organisms to a restricted dietary, as many of the fermented products are consumed daily, and often in large amounts For example

(a) the average daily consumption by the men of a Nyasaland village of fermented cereal gruel (commonly known as Kaffir beer) was 11 pints, over a period of five months
(b) the average daily consumption by the Annanmites of nuoc-man (a fermented fish product) has been estimated as 40g per head, which is said to supply 8 per cent of the nitrogen (protein) requirements, and the annual trade in Indo-China is about 100 000 tons, all of which is absorbed by the home market[4],
(c) the daily consumption by the Japanese of soy sauce is said to be 2 5 oz (71g) per head, and the annual production in Japan alone is considerably over 2 million barrels[5]

The fermentative processes entailed in the preparation of the products in the following list involve the active participation of micro-organisms There is, however, a group of fermentations,

brought about by agencies (enzymes) developed within the material fermented, in which micro-organisms may be present but are probably not essential to the process Examples of this group are found in stages of the manufacture of tea, coffee and cocoa, and in the steeping of cereal grains and pulses Processes of this nature affect the nutritive value of a foodstuff but they need not here be considered further, except to note that they may and do occur along with microbial fermentation

EXAMPLES OF FOODSTUFFS AND BEVERAGES INVOLVING FERMENTATION BY MICRO-ORGANISM[5]

Cereals e g wheat, rice, maize, barley, rye, oats, sorghums, millets

(a) Leavened bread (wheat and rye, sometimes other cereal meals are used as diluents)
(b) Savoury cakes *wähe* cakes - fermented wheat flour crust with various fillings - Switzerland, *Liebenwerdaer Speckkuchen* - baked fermented rye flour, sour cream, bacon filling - Germany; *chak how joo, chin tui, pek tong quay* - made from fermented dough - Canton
(c) Sweet cakes *barm brack* - Ireland, spice bread - Yorkshire; fresh plum cake and butter *kuchen* - Germany, and *babooky* - Czechoslovakia, are all made from fermented wheat flour and milk and sugar with fruit or nuts or other flavouring is added, *quay tepong manis* - fermented wheat dough stuffed with sugar and fried in coconut oil - Hainan
(d) Dumplings *pao-tse* - fermented wheat flour crust with savoury filling, steamed - North China, dumplings with yeast - wheat flour with yeast, egg and milk for *cruss* fruit filling, boiled in salt water - Czechoslovakia
(e) Fermented rice preparations *koji* - cooked rice fermented by *Aspergillus oryzae* - an ingredient of *miso*, and used in the preparation of soy sauce - Japan, *tapai pulut* - cooked rice fermented by the addition of fermented cakes of finger millet - Hainan *mah kok quay* - ground rice fermented with fermented flour paste steamed and made into cakes sweetened with sugar - Hokien and China, *iddalee masalay radai* - fermented mixture of gram and raw rice, flavoured with onion and curry powder or chillies - Tamil race of Southern India and Ceylon, *apom balik* - rice flour and sugar mixed, fermented with yeast, fried in coconut oil - Java
(f) Porridge and gruel *skabuputra* - sour gruel or grits made by fermenting boiled barley groats with butter milk and milk - recognized as a nourishing dish - Latvia *sican gwyn* and *llymru* (flummery) - made from oatmeal and buttermilk fermentation mixtures - Wales *sowans* - acid fermentation of sids (the inner husks of oat grain) - Scotland *umcuku* - boiled whole maize mixed with milk curds (*amasi*) and fermented with light maize beer - East Cape Province, South Africa (this is only one example of the preparation of a staple dish of a type in general use by the African in West, East, Central and South Africa Many of these staple dishes are disappearing with the introduction of machine-made mealie

(maize) meal The town-dwelling Zulu is, however, learning to ferment the European mealie porridge, and a dish *(amaheuu)* fermented after the addition of wheat flour is considered to be an excellent substitute for milk and curds *(amasi)* It has been remarked[2] that 'from birth till death the Zulu lives, in a very large measure, on fermented aliments')

(g) Beverages Fermented beverages are prepared in most parts of the world, and all kinds of cereals are used in their preparation Amongst primitive peoples the fermented liquids are generally consumed as thin gruels, e g. preparations of the type of Kaffir beer In modern practice, the nutrients of the micro-organisms are filtered off

(h) Soups *broch* - fermented wheat bran - is put into soups - Roumania

(i) Sauce wheat and barley are used in the preparation of soy sauce (see Pulses)

Roots e g taro and cassava

Poi - a staple dish obtained by acid fermentation of taro - Hawaii, *gari* - a staple dish made by allowing grated cassava to ferment for three days - West Africa Where cereals are difficult to obtain, in Nyasaland lakeshore villages, for example, the natives prepare a root beer, similar but inferior to Kaffir beer

Pulses

The grams are fermented along with rice in some Tamil dishes (see Cereals (e)) Far Eastern preparations include *miso* - a mixture of *koji* (see Cereals (e)) and soaked, cooked soya beans left to ferment for two months - eaten by rural people at the rate of about 40g per head per day - Japan, *natto* - a popular dish of fermented soya beans - Japan, *chou tofu* - bean curd *(tofu)* allowed to ripen and has a stink *(chou)* like Gorgonzola cheese - China, *shoyu* - mixture of equal parts of wheat or barley and soya beans - a long term fermentation (one month to two years, commonly about five months) by *Aspergillus oryzae* in the presence of salt - China and Japan, groundnut press cake, fermented - Java

Fruits coconuts, grapes, apples, pears, plums, etc

Examples are *bongrek* and *semaji* - press cake from coconut fermented by fungi (the former by species of *Rhizopus*) - Central Java Fresh coconut juice fermented to a toddy - used in the treatment of vitamin B deficiency - some Pacific Islands

Leaves and vegetable products

There are numerous herb beers and wines (e g. from clover, broom flowers and cowslips) made in England Fermented pigweed *(Amaranthus spinosus)* is a common drink of the Maori in New Zealand Several methods of pickling involve fermentation, e g. in the preparation of *sauerkraut* (Germany) and *sauerkohl* (Estonia) The sap and growing tips of some palm trees are fermented An infusion of tea with

sugar is fermented by the *combucha* tea fungus and is used as a beverage in Tibet, it is believed to be rich in ascorbic acid

Fermented milk and cheeses

Kefir (Caucasus) and *kumiss* (Near East and Russia) are fermented milks (goat's and mare's, respectively, although cow's milk is also used) and may contain about 2 to 3 per cent of alcohol *Joghurt* (Turkey), *kiselo mloko* (Balkans), *mazun* (Armenia), *gioddu* (Sardinia), *dadhi* (India), *leben* (Egypt) and *amasi* (Zululand) are acid-curdled products containing little or no alcohol and are made from goat's, cow's and water buffalo's milk There are numerous cheeses produced by fermentation and often ripened by special organisms It is not known to what extent these treatments affect the nutritive value of milk but they do have a preservative action, and the potentialities of milk as a vehicle for pathogenic organisms are reduced, for these organisms do not flourish in acid solutions

Fish

Nuoc-mam - a savoury sauce obtained by a combination of auto-digestion and anaerobic fermentation of fish - Indo China *trassi* - a preparation made by fermenting fish and shrimps, but the process is not allowed to go as far as in the manufacture of *nuoc-mam* - Java

REFERENCES

1 **Accessory Food Factors Committee** *(1945) M R C (War) Memor No 16, H M S O*

2 **Bryant, A T** *(1903) A description of native foodstuffs and their preparation Government Printer, Pretoria (out of print)*

3 **Colonial Food Yeast Limited** *(1944) Food Yeast - a venture in practical nutrition*

4 **Hardy, G & Richet, C H fils** *(1933) L'alimentation indigene dans les Colonies Françaises, p 66*

5 **Piper, C V & Morse, W J** *(1923) The Soybean, McGraw-Hill, New York*

6 **Platt, B S & Webb, R A** *(1946) Proc Nutr Soc, 4, 132*

7 **Platt, B S & Webb, R A** *(1948) Chem & Ind, p 88*

GAMBIAN METHODS OF PREPARING FLOUR FROM GRAIN

A demonstration showing the production of flour from sorghum grain was given by Gambian Staff of the Field Research Station The following description has been prepared by Miss M W Grant who studied the process when it was demonstrated by the same women during her visit in 1949

The method used in the Gambia is typical of many parts of Africa where hand-pounding with pestle and mortar* has not yet been superseded by power-driven mills, and it seems probable that the product may have nutritional advantages over ordinary machine-milled flour

The dry grain is winnowed to remove dust, chaff, hollow grains, etc

The grain is then placed in a wooden mortar, together with a little water†, and pounded with a hardwood pestle to loosen the bran, which is winnowed off This pounding takes about ten minutes for a quantity weighing about five pounds (2½ kg), approximately half-a-pint (280 ml) of water being added Considerable force is exerted and a pestle weighing about six pounds is used, but it is important not to break the grains by this treatment which is intended only to remove the bran

The clean separation of the outer layers appears to be facilitated by their becoming moist (from the water added) while the interior of the grain is still hard and dry Typical moisture contents at this stage are separated bran 35 per cent, separated grain 12 per cent (original dry grain 3 per cent)

After the bran has been winnowed off, the grain is well washed in plenty of water The grain is allowed to settle and the supernatant fluid poured off It carries with it bits of bran and small pieces of broken endosperm and is quite floury in appearance The wet grain is left for several hours, sometimes overnight, It may be covered or uncovered exposed on the hut roof to the sun or kept indoors in the shade The moisture content of the mass when set aside after washing averages 25 per cent.

A considerable degree of fermentation takes place at this stage, for example in one batch set aside at 9 45 a m the temperature in the centre of the mass two hours later was found to be 36 5°C and at the surface 33 2°C, in an environmental temperature of 30 6°C After the grain has been standing for six to eight hours (the usual period) distinct signs of germination can be seen root tips being sometimes as much as 1 mm long.

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* See frontispiece

† This treatment recalls the definition of 'conditioning' of grain (wheat) given by N L. Kent in Food Science (ed E G. Bate-Smith & T N Morris (1952) page 109 Cambridge) ' the application of heat water and air - for certain lengths of time in such a way as to facilitate the best separation of bran from the endosperm and as far as possible to improve the baking quality of the resulting flour' - Ed

The second pounding - which reduces the grain to flour - is regarded as a much lighter task than the first, though the actual time spent on it may be longer if it is desired to turn the whole batch into fine flour, more commonly, some is left in the form of a coarse meal, flour and meal being used for the preparation of different dishes Examination of individual grains just prior to this second pounding shows that they have become softened to such an extent that they can be broken down between finger and thumb, and the flour seems to be produced by a disintegration of the grains under pressure rather than by a splitting into progressively smaller pieces by forceful 'hammering', as would be the case if dry grains were pounded down

Fifteen minutes' pounding suffices to reduce approximately five pounds of soaked grain to a mixture of flour and small pieces similar to semolina These are separated by winnowing or sieving and the pieces returned to the mortar for further pounding if a greater proportion of flour is desired

The moisture content of such flour when freshly prepared is about 25 per cent It is used immediately and not sun-dried and stored as may be done in some other areas Analysis of a sample showed a high B-vitamin content, despite the removal of the bran The values found are given in the table, together with those for a sample of whole-grain sorghum flour prepared by machine-milling of dry grain Both are calculated to a 12 per cent moisture content for purposes of comparison

Analytical data for hand-pounded and machine-milled sorghum

per 100g	Sorghum flour	
	prepared as described	machine-milled
Fibre, g	1 3	2 0
Thiamine, mg	0 46	0 27
Riboflavin mg	0 13	0 11
Nicotinic acid, mg	3 7	3 1

To people accustomed to the fine flour prepared by traditional methods, a whole-grain meal seems very coarse and unpalatable, but refining of a dry milled flour results in heavy losses of B-vitamins, which appear to be satisfactorily retained (and possibly increased) by the methods described above It also seems probable that a flour produced in this way would be much more suitable for young children than one produced by methods which do not involve these fermentative changes or which retain a high percentage of fibre

FISH MEAL IN SOUTH AFRICAN BREAD

by

J M Latsky

Professor Brock described work being done in South Africa on the introduction of a protein concentrate prepared from fish into bread Some notes on these experiments have been submitted by Dr J M Latsky

On the South African Railways Native Compound at Koedoespoort an experiment has taken place in which an addition of 3 per cent fish meal to bread was made The percentage was increased weekly until, after three weeks, 8 per cent was being added, and this was continued for six weeks without complaint from the residents of the compound

At the Westford Institution for Lepers brown bread containing 3 per cent fish meal was given, but after three weeks this experiment was stopped as patients complained that the bread smelled and tasted sour, and they asked for a change to white bread However, the brown bread supplied to the Institution at that time was of poor quality, and it is possible that the fish meal had nothing to do with the complaint

At one stage of the work at Koedoespoort, bread containing 8 per cent fish meal was used at Westford Institution for about six weeks without comment from the patients

Trials along the same lines as those made at Koedoespoort were made at the Mental Hospital, Weskoppies, with the full knowledge of the Superintendent and staff Members of the staff who participated in the test reported that they detected a slight taste of fish meal when there was 6 per cent in the bread, though it could not be established whether this was because they knew of the presence of the fish meal in the bread

Bread containing 8 per cent fish meal was used without further complaint for five to six weeks after the experiment should have stopped

At Nelspoort Sanatorium fish meal replaced for two weeks the enriching mixture used in the making of brown bread Fish meal was also used occasionally in mealie meal but was not added to white bread as it might have changed the colour

Dr Latsky reports that acceptability tests have for the present been stopped, pending reports of an investigation which is still in progress, on the intrinsic nutritional value of fish meal

PREPARATION OF FERMENTED SOYA BEANS (TEMPE)*

by

E Baker Jones

Although soya bean is used extensively throughout the Far East as human food, it has not been successfully used to the same extent elsewhere It is well recognized as a good source of certain essential amino-acids and there are many parts of the world in which it may be grown without difficulty It can be grown in Southern Rhodesia where however, no serious attempt has yet been made to process the soya bean so as to make it a popular human food

Experiments in processing have been made in Southern Rhodesia in collaboration with an immigrant from Indonesia who is well acquainted with a product of processed soya bean, *tempe*, which was used in Changi Prisoner of War camp[1] The method of preparation which is now described is the result of many trials to discover optimal conditions for making the product in Southern Rhodesia Helpful information has been obtained from many sources, especially from Professor van Veen of the Food and Agriculture Organization

Soya beans are soaked in water overnight, then cooked till soft by boiling in water for about an hour The cooked beans are drained, cooled to about 36°C, inoculated with a culture of the mould *Rhizopus oryzae* and incubated on trays, in an atmosphere of high humidity, at 32 to 36°C for about 24 hours During this time it is important that the material should be ventilated and that the temperature should not rise above that specified, otherwise undesirable by-products are formed During incubation the mould grows throughout the mass of beans The products may be cooked immediately by boiling, roasting, baking or frying, or it may be preserved by drying

The action of the mould on the soya bean has been investigated by van Veen and Schaefer[2] The product contains 62 per cent moisture, 22 per cent protein, 11 per cent fat 1 8 per cent ash and 3 per cent total carbohydrate The product *tempe*, is more digestible than the original soya bean due, apparently, to proteolysis occurring during growth of the mould, when the *tempe* develops a distinct pleasant meaty flavour in place of the original unpleasant bitter flavour of the untreated bean

Certain varieties when grown in drought years are very resistant to absorption of water and efficient peeling of the bean is, in consequence, difficult

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* A note by Dr Baker Jones on the preparation of soya eans which was available to members of the Conference has now been revised in the light of information received from Mr W R Carr, Food Technologist Southern Rhodesia

A letter dated June 1953 from Dr Baker Jones says 'The pilot plant for tempé production, constructed by our local Farmers' Co-op is expected to come into operation in a week or two '

REFERENCES

1 Smith, D A & Woodruff, M F A (1951) *Spec Rep Ser med Res Coun*, Lond, No.274

2 van Veen, A G & Schaefer, G (1950) *Docum neerl indones morb trop*, 2, 270

PREPARATION OF SOYA BEAN AND BANANA DIET

by

R F A Dean

Diets of a soya bean and sweet banana* preparation have been used for nearly a year at Mulago Hospital, Kampala, in the treatment of kwashiorkor The chief difficulty is processing the soya bean A simple method, designed to make the beans palatable and easily digestible and to render the trypsin inhibitor innocuous, is outlined

Raw beans are soaked in water for 24 to 48 hours during which they swell considerably They are then squeezed under water the husks fall away, and the halves of the beans are easily separated The beans are minced in a kitchen mincing machine and packed into Kilner jars to within 4cm of the top Water is poured into the jars, leaving only 2cm free and the caps are fitted loosely The filled jars are placed in a large vessel with water up to their necks, and the water is brought to the boil and kept boiling for eight to ten hours The beans should then form a soft mash which can easily be made into a smooth paste by pressing between the finger and thumb It should have a slightly beany flavour - not at all unpleasant The soya mash is then ready for use in making the soya bean - sweet banana diet At Mulago this is usually done in an electric blender

In the table the composition of a sample ration is given

Composition of sample ration of soya mash – sweet banana mixture

	Protein g	Fat g	Carbohydrate g	Calories
300g soya mash	51	25	17	500
750g sweet banana	8	-	144	540
75g sugar	-	-	75	280
Total	59	25	236	1 320

The protein provides 18 per cent of the total calories A vitamin mixture provides about 15mg cyanocobalamin (vitamin B_{12})

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* See footnote, page 310

DISCUSSION

Professor JACQUOT, replying to a question raised by Professor Bigwood as to how far diet could influence the chemical composition of skin and hair, said that he knew of no experiments carried out on man* However, numerous experiments had been made on laboratory animals, particularly rats, from which two definite conclusions could be reached firstly that from the quantitative point of view there existed a certain relationship between the amounts of cystine and of methionine in the diet and the amount of hair produced, and secondly that lack of nitrogen influenced the chemistry of the hair

It had thus been demonstrated that the regenerated hair of the rat fed on insufficient protein contained far less cystine than normal hair The experiments had shown that reduced cystine was the only characteristic factor, because the rates of methionine, lysine and tryptophan were normal A study of the amino-acids as a whole had not been made, but experiments carried out in Australia and New Zealand led to the conclusion that cystine alone might vary in the hair, whereas the other amino-acids were maintained at normal levels There would seem, therefore, to be no question of an alteration in the chemical characteristics of keratin but rather of morphological alterations in the hair with diets poor in nitrogen, the hair showed an empty medullary canal whereas normally it was filled with keratinized cells Since it was known that cystine was mainly found in the medullary canal, which held more than the cortex, it was understandable that the disappearance of the cells from the canal entailed a reduction of cystine in the hair as a whole

It would be interesting to follow up similar studies in kwashiorkor with a view to ascertaining to what extent the lack of nitrogen - probably the cause of the disease - brought about alterations in the chemistry of skin and hair

Professor JANZ said that the absence of cystine in the diet, as Mackenzie and du Vigneaud had proved, caused an increase in oxidation of the methyl groups, perhaps because the methionine was then used as a source of sulphur in the synthesis of cystine This showed that the complexity of the metabolic effects characteristic of multiple partial deficiencies was not merely the sum of the effects of a number of isolated partial deficiencies

Professor MONCRIEFF referred to a case of cystinosis recently studied in which the hair was particularly sparse, although the cystine content was normal Had it been possible to estimate the total amount of hair, it would no doubt have been found that the total content of hair-cystine was greatly reduced

Professor GYORGY commented on the nature of APF and its relationship to vitamin B_{12} (cyanocobalamin) He said that, owing to the high cost of liver, commercial firms had started producing B_{12} through fermentation by strains of streptomyces It was then established that B_{12} alone was not a substitute for fermentation mash At

* See, however, p 215 - *Ed*

present, APF was considered to be a combination of B_{12} and antibiotics, possibly with other additional factors (B_{13}, B_{11}) not yet chemically identified

Referring to Professor Bigwood's comments about the presence of certain substances in human milk but absent from cow's milk, he said that the former contained a group of polysaccharides, ranging from low to high molecular compounds In cow's milk, however, the polysaccharide content was very low, only 1/50 to 1/100 of that found in human milk. The chief constituent of these polysaccharides was N-acetylglucosamine which, on acid hydrolysis, would yield glucosamine, as indicated by Professor Bigwood The other constituents were fructose, glucose and galactose These four saccharides formed the so-called repeating unity of Morgan in blood-group polysaccharides The milk polysaccharides had microbiological growth activity for a particular strain of *Lactobacillus bifidus,* growth activity for rats fed on a low protein diet, and anti-viral effects against certain virus infections

Professor BIGWOOD agreed with Professor Jacquot about the role of cystine but wondered whether other sulphur organic compounds influenced the growth of hair In his view more information was required about sulphur-containing substances

Referring to Professor Moncrieff's comment, he said that in cases of cystinosis, where cystine crystals were deposited in body tissues, the hair might be expected to show a normal sulphur content A study of the complete amino-acid composition of the hair and skin was required but, short of that, an analysis of ratio of sulphur to nitrogen should be made

Professor MAYNARD paid a tribute to Professor Bigwood on the results obtained by the use of the chromatographic method He also agreed with Professor György about the definition of APF

Professor BIGWOOD wished to pay his debt of gratitude to Dr S Moore of the Rockefeller Institute for Medical Research in New York who initiated the chromatographic method on ion exchange columns for amino-acids, in collaboration with W H Stein This method has been used in Professor Bigwood's laboratory since 1950, when Dr Moore spent the winter semester of 1950-1 at Brussels University as Visiting Professor ('Francqui' Chair)

Professor BROCK was of the opinion that the discussion - although extremely interesting - had gone beyond the main subject matter under consideration namely, that there was definite ecological evidence to prove that kwashiorkor developed where diets were deficient in protein both quantitatively and qualitatively, particularly when the intake of carbohydrates was high in proportion to the protein What was essential was a clear restatement of the fundamental issues presented in such a way as to be clearly understandable to governments and administrators He had drawn attention to the fact that in certain parts of Africa where starvation was frequent, the incidence of kwashiorkor was nevertheless low, because of the fruit and beans

produced locally In one bush community where a combination of bean and nut mash, as a milk substitute, had been used as post-weaning food, no kwashiorkor had occurred That was evidence to show that high starchy diets with low protein quality were not inevitable

He pleaded for greater emphasis on the urgent and practical need to teach African people to produce and use proteins locally available, whether of animal or of vegetable origin The attention of administrators should be specifically drawn to that point

Professor MONCRIEFF, in advocating the use of the traditional 'stock pot' as a means of including all necessary elements of food, asked whether it had ever existed in Africa and, if not, whether it could be introduced He said that during a period of industrial depression on Tyneside, fewer children had been affected by dietary deficiency than might have been expected, largely because of proper maternal care and the availability of soup which was particularly useful as a post-weaning diet, as it was made up of every kind of ingredient and therefore contained a great variety of food elements He recalled a picture of a scene depicting Africans dancing round a pot Was this a stock pot?

Professor PLATT agreed with Professor Moncrieff about the nutritive value of soup and said that a procedure resembling that used in the preparation of the stock pot was used in parts of Africa Fish, for example, were cooked repeatedly so that ultimately the bones were so softened that they could be eaten The pot around which the Africans danced was, however, probably not a stock pot but a beer pot He had in the past drawn attention to the nutritional merits of fermented grains (see page 271) and recalled a recommendation made half a century ago[1] that the traditional Kaffir beer should not be eliminated until its contribution to the dietary could be made good in other ways

Dr McGREGOR wished to draw attention to one point which he, as a field worker, felt to be most important He said that the food supplies of the rural population in the Gambia were subject to violent fluctuations*, not only in quantity but also in quality For example, during the dry season, cereals harvested after the rains were consumed in large quantities but over the wet season cereal supplies became exhausted and the people lived on fruits, nuts and the leaves of trees collected from the bush Thus, the two seasons differed not only in the amount of food eaten but also in the type of food consumed

The effect of this seasonal dietary fluctuation could be detected in changes in the nutritional state of the population In the Gambia a high incidence of signs of vitamin B_2 deficiency e g glossitis angular stomatitis and cheilosis, was found during the dry season, but these signs diminished in frequency throughout the rains

* 'the hungry season' - see page 225 and *Lancet (1950)* 1, 1002 —*Ed*

On the other hand, dyspigmentation of the hair in children and adolescents reached its maximum incidence during the rains but diminished in the dry season Was it a case, then, of a particular set of deficiency signs produced by one diet in one part of the year being cured in the remainder of the year by an entirely different diet?

He wished to stress the importance of keeping in mind such possible seasonal dietary fluctuations whenever clinical nutritional surveys in rural areas were contemplated He felt that it was wrong to conclude that nutritional deficiencies detected during a survey made at one period of the year were necessarily present throughout the entire year

Professor BIGWOOD discussed the results of analyses of the amino-acid content of cotton seed protein He said that cotton was an important cash crop in the Belgian Congo and that in the search for food proteins of a satisfactory biological value it was necessary to turn to cotton seed The difficulty lay in the toxic constituent of cotton seed oil, gossypol, which had somehow to be removed That difficulty could, however, be overcome by suitable technological treatment, preferably by chemical rather than by mechanical extraction

An analysis had been made of an American cotton seed fine flour sample, as prepared for human consumption, and would be followed by analyses of samples of cotton seed obtained from the Belgian Congo A preliminary analysis of the American sample showed 9 4 per cent nitrogen, hence more than 50 per cent 'crude protein' The provisional chromatogram, which he showed, did not include data on the cystine and tryptophan content The data concerning 16 other amino-acids found in the sample, including ammonia nitrogen (the humin nitrogen was negligible) covered 97 5 per cent of the total nitrogen content the remaining 2 5 included the nitrogen from cystine and tryptophan The analyses showed that the proportion of essential amino-acids was of the order of 30 per cent, which compared satisfactorily with the level for cereals (in meat and milk the proportion had been found to be about 40 per cent of the total amino-acids, whereas in cassava meal it was only about 23 per cent) It had been found that the amino-acid content of cotton seed protein was relatively high in lysine and other essential amino-acids but that on the other hand it was conspicuously low in methionine If, then cotton seed protein was to be used as an edible protein of vegetable origin because large quantities were available it would be necessary to compensate its methionine deficiency by means of other vegetable proteins rich in methionine It was intended to find out whether sunflower protein could be used for this purpose or whether some other source of vegetable protein must be looked for

Professor JACQUOT pointed out that all oil-seeds offered a fair balance of amino-acids, sunflower seed being among the best It was particularly rich in lysine and so, in combination with soya beans or groundnuts, would give all the amino-acids required

Professor DAVIES, in answer to a question asked earlier, said that a study of the sunflower seed figured in Dr Dean's research plans He wished to add that the dissemination of the results of research was just as important as the work of research itself he personally had been totally ignorant of the invaluable work of Professor Bigwood on the analysis of amino-acid patterns

Professor RAOULT, in the course of summarizing the discussion, noted that, whereas there were few kwashiorkor cases in the Gambia, the disease was common in Nigeria and was sometimes accompanied by infectious gangrene of the mouth A point of great interest was that where the staple food could be supplemented by proteins obtained from hunting, few cases of kwashiorkor occurred He stressed the importance of lipids, palm oil in Nigeria and groundnuts in the Gambia It was, he thought, essential to define to what extent groundnuts affect the incidence of kwashiorkor He wondered whether an adequate supply of meat protein could be obtained from poultry, as was the case in Togoland

REFERENCE

1 Bryant, A T (1903) *A description of native foodstuffs and their preparation*, Government Printer, Pretoria (out of print)

MALNUTRITION IN MOTHERS; AND TREATMENT AND PREVENTION OF MALNUTRITION IN INFANTS AND CHILDREN

Chairman Professor J. F. Brock

SOME NUTRITIONAL IMPLICATIONS OF THE MOTHER-INFANT INTERRELATIONSHIP

by

B. S. Platt

Until recently the concept of the parasitic nature of the foetus on the mother was generally interpreted as meaning that the mother supplied from her tissues the nutrients required for the growth of the foetus, even if to meet these requirements she had to sacrifice some of her tissues There is, however, an increasing amount of evidence[1] 'that the fetus is parasitic on the mother to a degree depending on the mother's nutritional condition when she enters pregnancy as well as on the quality and quantity of her diet during pregnancy', that is to say, food shortages are shared by mother and infant, and the effects of malnutrition on the mother are reflected in the state of nutrition of the offspring. I have reported[5] some data on birth weights and lengths in various tropical countries in relation to the social status of the mother and, in this connection, the evidence of Burke *et al* was quoted to show how closely the birth weights and lengths of infants correlated with the protein in the mothers' diets It seems likely that a record of birth weights of infants may provide a useful indicator of the state of nutrition of mothers and possibly of the community generally It may indeed be worth while keeping records and scrutinizing them from time to time, even when there is no overt evidence of malnutrition

There is a possibility that underweight infants - which by definition may be classed as premature - are, in fact, full term such infants may, indeed, be immature Investigation of this possibility is important it may have a bearing on the subsequent state of nutrition of the young child Another possibility is that the provision of a plentiful supply of human milk may be of special importance to the immature infant

Little is known about the peculiar value of maternal milk for human infants, nor is the significance for mother and infant of various infant feeding practices, e g frequency of contact at the breast, duration of breast feeding, and methods of weaning understood The results of an investigation of the behaviour of milk in the stomachs of experimental animals (see page 291) suggest that a similar investigation in human infants might be profitable and provide the basis for a new approach to the study of the nutritional value of the various milk fractions

A good deal of confusion about infant feeding, in my view, arises from a loose use of the term 'weaning' 'To wean' is 'to teach to feed otherwise than from the breast' (OED) and the idea is that the infant is disengaged or cured from the habit of feeding at the breast It is too often assumed that when an infant is given food additional to the breast, it is being weaned The term 'mixed feeding'[6] might be applied to the process of giving food *as well as* breast milk, the term 'weaning' being reserved for the process by which the child is fed otherwise than from the breast One point worth noting is that the weaning process can be facilitated by giving the child food before it takes the breast feed, so that its demand on the breast is reduced. Since the amount of milk secreted is determined by the extent to which milk is drawn off the breast, with reduced demand secretion falls off

There is only scanty information about foods used for mixed feeding of infants In a study[6] of infant feeding practices in China the possible significance of the feeding of starchy foods as a means for developing later in life a good capacity for digesting and absorbing predominantly carbohydrate diets is mentioned A custom, which is common among unsophisticated people, of early introduction of starchy foods should not be condemned without more knowledge, like many traditional practices in feeding, it may prove to have special value, at least in the circumstances in which it is applied

Another usual feature of infant feeding among unsophisticated peoples is continued feeding at the breast for what are, by European standards, long periods, for up to four or five years, or even longer, is not unknown Observations made in 1938-9 on a group of 98 infants in some Nyasaland villages on the duration of breast feeding are shown in figure 1 The twenty-fourth month was the commonest time for weaning. There was a close parallel between the duration of breast feeding and the interval between pregnancies, values for which are shown for women in Nyasaland villages in figure 2

It is the custom in communities in which polygamy is practised for a wife to live apart from her husband for a year or two, or even longer, after a pregnancy At the end of this time she may become pregnant again and this occurrence may be the occasion of weaning the suckling infant In a discussion of African practices concerning the fertility of women, Krzywicki[3] quotes an analysis of the duration of marital abstinence (see table).

The significance of weaning too early by traditional standards is well recognized In Nyasaland the infant which deprives its predecessor of its full birthright of breast feeding is given a name which carries a stigma for the mother for conceiving again 'too soon' The same idea is inherent in the term 'deposed child' - the child who becomes a victim of kwashiorkor[8]

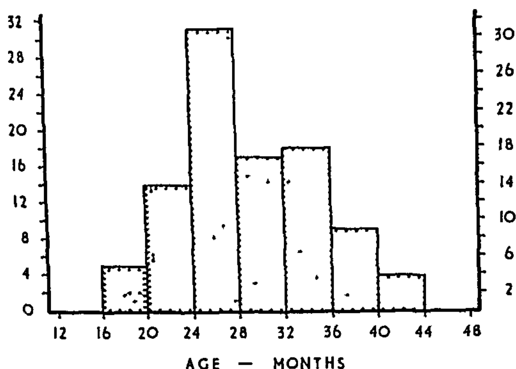


Fig 1 Frequency distribution of age at which 98 children from Nyasaland villages were taken off the breast

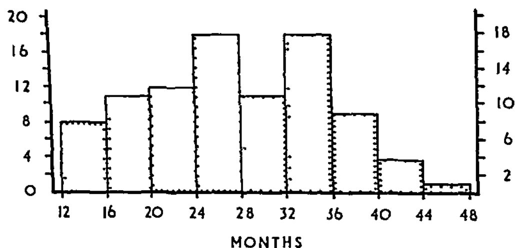


Fig 2 Frequency distribution of the interval between successive full term births in three Nyasaland villages

Duration of marital abstinence for 62 males of an African tribe

As long as he likes	2
For one month	1
For about six months	2
For a year	12
For eighteen months	1
Till the child can walk well and take its own food	10
From one to two years	2
From one to three years	2
For two years	7
From two to three years	5
For three years	13
From three to four years	1
Till the end of suckling	2
For an unspecified time	2

Most workers engaged in nutritional or paediatric studies in tropical countries have early in their careers an urge to produce a substitute for human or cow's milk It would, in my view, be much more desirable to devote attention to two other problems firstly, the study of how the mother should be fed so as to enable her to feed her infant adequately from her breasts, and secondly, the determination of the value of foods suitable for continuing the practice of mixed feeding I support the view of Dr Ruth Guy, that 'unless there is enough breast milk and until the child is able to feed without help, food is likely to be insufficient until about the eighteenth month This is due not only to the expense and trouble involved in the preparation of special food, but also to a lack of patience at the inevitable slowness of the child If, however, the child can be assured of a supply of 500 to 700 c c of maternal milk in addition to its share of the family diet, it is believed that the difficulties of this weaning period will be overcome '

Of special relevance to the first suggestion for study is the observation of Balfour (see page 122) that on the 'Gambian diet' mother rats invariably eat their offspring So far as results of observations on experimental animals can be applied to the human, the need for improvement of the Gambian mother's diet would seem to be urgent A supplement of fish meal prepared so as to conserve the biological value of its protein would be worth while investigating for this purpose

As items of mixed feeds there are grounds for recommending various rice preparations[4] I favour the use of soya bean curd rather than of the 'milk' prepared from these beans Bananas have been used in paediatric practice for many years, their introduction being associated with the work of Thursfield[7] who used them successfully in the treatment of marasmus in infants A preparation from *poi* - fermented taro (yam) -has been claimed to have value for infant feeding[2] This brief list is by no means exhaustive

I deprecate the view that a supplement should be 'milk-like', i.e as to appearance and consistency, the physical properties of milk can have no obvious appeal to the breast fed infant, and a cooked supplement is especially desirable in communities in which the water supply is likely to be contaminated.

In conclusion, may I reiterate that the predominant interest should be in the study of human lactation with a view to improving infant nutrition by better breast feeding, and may I also plead that when the milk supply of a community is assessed, the contribution of the human mother should not, as is nearly always the case, be overlooked

REFERENCES

1 Burke, B. S. & Stuart, H. C. (1952) *Handbook of Nutrition*, 2nd Ed, Amer Med Assn, p 299, Lewis, London

2. Crawford, D. L. (1937) *Hawaii's Crop Parade*, p 206, Advertiser Publishing Co, Honolulu

3 Krzywicki, L. (1934) *Primitive society and its vital statistics*, p 202, MacMillan, London

4 Platt, B. S. (1936) *Chin med J*, 50, 410

5. Platt, B. S. (1948) *Royal Society Empire Scientific Conference Report*, 1, 587.

6 Platt, B. S. & Gin, S. Y. (1938) *Arch Dis Childh*, 13, 343

7. Thursfield, H (1927) *Arch Dis Childh*, 2, 49

8 Williams, C. D. (1933) *Arch Dis Childh*, 8, 423

OBSTETRICAL DATA - MULAGO HOSPITAL, 1951-2

Collected by

C Rendle-Short

Between January 1951 and 20th October 1952 there were 84 still births out of a total of 1,067 births in the hospital, 50 of them were from obstetrical causes and 20 from medical causes, mainly high fever and gross anaemia, and the remainder were from uncertain causes Congenital abnormalities (only eight cases) were fewer than expected Premature live births numbered 186, 158 of the children remained alive Of the 45 neonatal deaths, post-mortem examinations had been performed on only four, the causes of death were (a) prematurity, (b) cerebral haemorrhage (two) and (c) prothrombin deficiency Of the remainder, 28 were attributed to prematurity (under 5½lb -2 4kg)

BEHAVIOUR OF MILK IN STOMACHS OF EXPERIMENTAL ANIMALS

by

B S. Platt

In my communication I referred to an investigation, a brief statement of which has been reported and which, for ease of reference, is quoted.

'Among primitive peoples, infant feeding differs in two main features from the practice in more sophisticated societies - the infant is fed "on demand" and the period at the breast is generally a matter of years rather than of months It has been found that the contents of the stomach of the infant rat form a cheesy mass arranged in layers and that the portion of milk last taken surrounds that already in the stomach which in the case of "on demand" feeding is rarely empty (see figure), this is the reverse of the arrangement of layers found by Grutzner in adult rats when the portions of bread and milk paste last eaten were found surrounded by shells of earlier portions Preparations made from the stomach contents of baby rats maintained at the breast showed the remains of a clot from a feed taken more than twenty hours previously The stomach contents after a breast feed taken on an empty stomach showed no stratification, much mucus and many air pockets Normally the emptying of the stomach, apart from the departure of the whey fraction, depended on erosion of the pole of the clot by regurgitated duodenal juices Investigations are being made into the fate of the whey and the changes which may occur in the curd fraction during its long stay in the stomach, including the absorption of lactalbumin, the rate of liberation and absorption of the products of digestions of casein, and the role of certain enzymes, e g. xanthine (pterine) oxidase in milk in relation to the time of their appearance in other infant tissues '

This observation might explain the 'milk cast' referred to by Dr Dean * Milk probably does not behave in the stomach as a liquid foodstuff Failure to recognize this, if in fact the behaviour of milk in the human stomach is similar to that in the rat (or in the kitten, in which similar changes to those in the rat have been observed), is in part, at any rate, the result of methods of making observations on stomach function, whether by radiological methods or employing the test meal, since both these techniques start with an empty stomach

REFERENCE

1 London School of Hygiene and Tropical Medicine *Report of the Work of the School for the year 1949-50, p 51*

* see p 311.

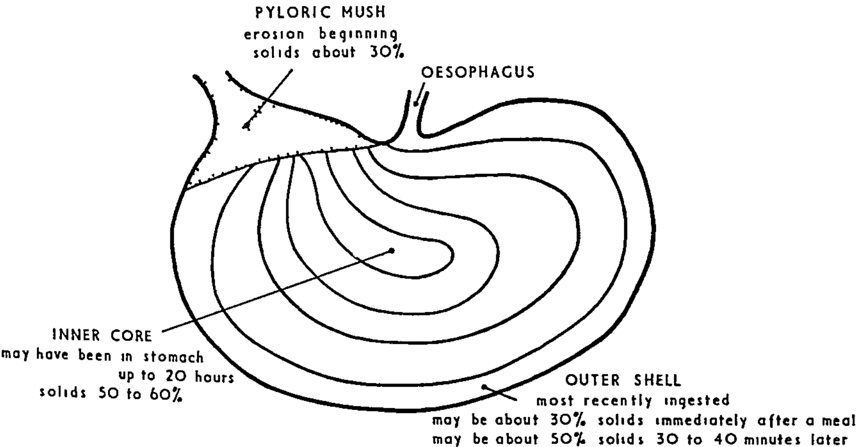


Fig Diagrammatized section of contents of stomach of a suckling rat

ANAEMIA AS AN INDICATION OF PROTEIN DEFICIENCY IN PREGNANCY

by

A W Woodruff

Anaemia is common among pregnant women in Nigeria and in investigating its cause it became apparent that malnutrition is an important factor It was at first thought possible that deficiency of specific haemopoietic substances might be responsible for these anaemias, evidence accumulated, however, which suggested that deficiency of protein is probably more important than that of other substances

The patients were all pregnant women living in or near Ibadan, Nigeria, and belonged to either the Yoruba, Ibo or Hausa tribes. In the course of a routine ante-natal examination it was found that the majority were suffering from anaemia, but others attended hospital complaining of lethargy, weakness dyspnoea or palpitations An outstanding clinical finding among these women was the presence of hepatomegaly and/or splenomegaly In patients in whom cardiac failure could be excluded, there was enlargement of both liver and spleen in 19 of 25 cases

The obstetric histories of those anaemic women who had previously borne children revealed a remarkable incidence of twin pregnancies, and a high neonatal mortality rate Also the birth weights of these children were abnormally low Thus 51 children were born of 21 of the women Of these children 32 died in the first year of life and 26 in the first month of life Six of the 21 women had previously borne twins and two did so again while under observation.

The birth weight of 18 of the children was determined The mean was 4 lb 9 oz. (2.07 kg) and the range, 1 lb. 11 oz. to 6 lb 7 oz (0 77-2 92kg) Jelliffe[2] found the mean birth weights of healthy African children in Ibadan to be 6 lb 5 oz. (2.86kg) All but two of the children in this series weighed less than this figure, and nine of them were born prematurely

Dietary data

The hospital did not supply meals to patients and food was therefore brought thrice daily by friends and relatives This food was weighed and its estimated constituents and calorie values are shown in the table Miss M W Grant has kindly examined the data on which these figures are based and states (personal communication), 'The higher figures are probably over-estimated by up to 30 per cent due to the fact that the water content of the flour used is likely to have been higher than the figure allowed for' This means that the women's diets probably provided less than 1g protein

per kg body weight daily and this protein was obtained almost entirely from vegetable sources

Constituents of the diets of 13 patients

Case No	Daily protein consumption (g)	Daily carbohydrate consumption (g)	Total Calories provided by dietary protein and carbohydrate	No of days food weighed
5	38	362	1,600	2
6	66	390	1,824	1
9	65	626	2,764	2
11	63	727	3,160	2
13	69	619	2,752	2
14	86	716	3,208	2
17	26	216	968	2
18	55	513	2,272	2
20	56	480	2,144	2
21	47	396	1,772	4
22	73	591	2,656	2
24	56	358	1,656	3
25	40	315	1,420	2

Plasma proteins were estimated in 22 cases, the mean value was 7 35 and the range 4 9 to 8 7g per 100 ml In 15 cases the proteins were fractionated and the following values were obtained albumin, mean 3 48, range 2 2 to 4 1, globulin, mean 3 64, range 2 6 to 4 7, fibrinogen, mean 0 48, range 0 1 to 1 2. Normal figures quoted by Harrison[1] are total 5 8 to 8 6, albumin, 3 4 to 6 7, average 4 globulin 1.2 to 2 9, average 2, fibrinogen 0 20 to 0 40, albumin globulin ratio (A G) 4 1 to 1 2 1, average 2 1 By comparison with these, the albumin fraction was below the average in 13 of the 15 patients in whom it was estimated and the globulin fraction above the average in all 15 patients The A G ratio was lower than average in all cases

The liver histology was studied in 24 cases and an increase in the fibrous tissue was present in almost all In other instances fatty infiltration was present and particularly affected the periphery of the liver lobule The changes were similar to those reported in malignant malnutrition and other protein deficiency diseases

Haematological data

The blood picture in these women has been described in detail elsewhere[11] In brief the anaemia is characterized by an increase in the diameter of the red cells and a diminution in their thickness, a haemolytic tendency is also common, while the bone marrow almost invariably is of the macro-normoblastic type This anaemia tends to become most severe in the last three months of pregnancy and to remit spontaneously after parturition Treatment before parturition is followed by disappointing results, and administration of Marmite, cyanocobalamin (vitamin B_{12}), folic acid, and iron failed materially to improve the blood picture During the puerperium there was a marked tendency towards spontaneous remission

In view of the dietary evidence of protein deficiency, the disturbance of plasma proteins, the changes in the liver suggestive of protein deficiency and the ineffectiveness of folic acid, cyanocobalamin, iron, and Marmite, two patients were treated with large doses of Casilan (Glaxo Laboratories Ltd) This substance is prepared from milk. It is composed of 90 per cent of protein which contains some of all the essential amino-acids, 1 per cent each of fat and carbohydrate, 4 per cent mineral salts (0 3g calcium per ounce less than 1 per cent sodium), and 4 per cent water

It was administered in the food in amounts of 200g daily for 12 and 13 days respectively In neither case did any significant increase in the reticulocyte count occur, though during the period of treatment the haemoglobin rose from 7 28 and 7 83 to 8 10 and 9 5g per 100 ml respectively During the same period the red blood cells rose from initial counts of 2 44 to 3 09 and 3 31 million per cu mm respectively These suboptimal responses to high protein therapy show that during pregnancy the pathological process producing the anaemia may not be wholly reversed by the administration of protein alone Some patients while having similar diets complained of marked indigestion with flatulence and abdominal distension It seemed that they were unable to digest fully the protein given them, possibly as a result of coincident pancreatic damage

Discussion

Though suboptimal, the haematological response following treatment with a high protein diet was better than that produced by haemopoietic substances This suggests that protein deficiency is more likely to be the cause of the anaemia than is deficiency of such substances The characteristics of the anaemia in these pregnant women are consistent with such a view and are similar to those described by Trowell and his colleagues[9, 10] in protein deficiency states This is probably also true of the anaemia so commonly reported among pregnant women in tropical regions other than West Africa, and perhaps particularly in the cases studied by Napier and his co-workers[4, 5, 6, 7, 8] This view is supported by dietary studies, plasma protein values, histological findings in the liver, by the fact that the anaemia is most severe in the last three months of pregnancy, i e when the demand for protein is greatest, and by the high incidence of twin pregnancies among these anaemic women The low birth weight and the high neonatal and infantile mortality are possibly also the results of deficiency of foetal building materials and particularly of protein

Many of the women no doubt commence pregnancy with livers damaged by malnutrition in childhood, but it is probable that some of them suffer further hepatic damage during pregnancy Certainly the fatty changes seen suggest recent dietary inadequacy If the effects of protein deficiency are common in childhood because growth increases the demand for protein, then such effects might also be expected in pregnancy Here the demand in the last three months of foetal growth may be proportionally greater than that in childhood

Finally, the liver damage present in these cases rather than deficiency of haemopoietic factor may account for the macrocytosis usually found Larsen[3] has shown that in patients with such damage the red blood cells are commonly abnormally broad, but thin, so that their volume may be little raised though their diameter is increased.

Summary

Anaemia is common among pregnant women in Nigeria and becomes most severe in the last three months of pregnancy

The red blood cells in such patients tend to be abnormally broad and thin

The bone marrow is usually of the macro-normoblastic type.

The livers have been shown to be diffusely fibrosed in many cases and infiltrated with fat in others.

The plasma in these cases almost invariably shows diminution in the albumin and increase in the globulin fractions

The patients' diets have been found to be low in protein

The anaemia is usually refractory to treatment before parturition

A high protein diet, though followed by suboptimal responses, appears to be more effective in treatment than other haemopoietic substances.

In pregnancy, and particularly in twin pregnancies, the demands of the foetus for protein may aggravate dietary protein deficiency and injure the liver or increase pre-existing liver damage

Liver damage rather than deficiency of haemopoietic substances may be responsible for the increased red cell diameter in these cases.

It is suggested that anaemia may be an indication of protein deficiency in pregnancy

I am indebted to Dr J C. L Adams for treating the two patients with Casilan, to Mrs I Cameron for the haematological estimations in these cases, and to Glaxo Laboratories Ltd for the supplies of Casilan

REFERENCES

1 Harrison, G A (1947) *Chemical Methods in Clinical Medicine* 3rd ed Churchill, London p 334

2 Jelliffe, D B (1952) *Trans R Soc trop Med Hyg* 46, 13

3 Larsen, G (1948) *Acta med scand Suppl* 220

4 Napier, L E (1936) *Lancet*, II, 679

5 Napier, L E , Das Gupta, C R , Chaudhuri, R N , Sen, G N , Rai Chaudhuri, M N , Sen Gupta, P C & Majumder, D N (1938) *Indian med Gaz* , 73, 385

6 Napier, L E (1940) *Indian J med Res* , 27, 1009

7 **Napier, L E & Edwards, M I N** *(1941) Indian Medical Research Memoirs No 33, Indian Research Fund Association*

8 **Napier, L E & Edwards, M I N** *(1942) Memorandum on Anaemia in Pregnancy in India, India Research Fund Association*

9 **Trowell, H C** *(1951) Lancet,* **ii,** *761*

10 **Trowell, H C , Davies, J N P & Dean, R F A** *(1952) Brit med J ,* **ii,** *798*

11 **Woodruff, A W** *(1951) Brit med J* **ii,** *1415*

ANAEMIAS OF PREGNANCY IN GOLD COAST AFRICANS

by

G. M. Edington

Of 123 consecutive cases of anaemia admitted to the Maternity Hospital, Accra, 63 per cent were normocytic, 26 per cent macrocytic and only 11 per cent microcytic. Severe anaemia, haemoglobin value of 4g. or less, per 100 ml. of blood was frequently seen, only 40 of the 123 cases (33 per cent) were hypochromic.

The only comparable figures in West Africa are those given by Gosden and Reid[2] who have classified the types of anaemia found in adult Africans in Sierra Leone. In their cases the normocytic type of anaemia was most common but the incidence of macrocytic and microcytic anaemias was the reverse of mine - a difference no doubt explained by the fact that my own findings were based on a selected group.

The response of many of the anaemias to haemopoietic drugs has been disappointing. Unfortunately, I have no record of serum protein levels and would like to congratulate Professor Woodruff[3] on his paper, as his supposition might well explain the lack of expected response to treatment.

The low incidence of hypochromic anaemia is, I think, of interest, and appears to suggest an unusual type of iron metabolism in the Gold Coast African. Much further work on the problem is clearly required.

I would urge that some attention be paid to African mothers in the study of dietary deficiencies. In the Gold Coast, the incidence of liver enlargement, splenic enlargement and signs of malnutrition have been found to be more common in women than in men of a comparable age group, the figures for these various signs in women of child-bearing age being 30 per cent, 30 per cent and 21 per cent respectively[1]. Little reference has been made in the discussion at this Conference to the influence on the new-born child of malnutrition in the mother. In the Gold Coast, fatty infiltration of the liver (normal or abnormal), the type III distribution* of iron pigment in the liver, and haemorrhagic catastrophies have been commonly found at autopsies on new-born babies.

At present my colleague, Dr Harris, is investigating the prothrombim times of mothers and new-born infants. It will be interesting to know if he finds any relation between enlargement of

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* see page 115

the liver in the mother and haemorrhagic manifestations in the new-born The treatment of malnutrition in the mother may protect the new-born African child in the Gold Coast from neonatal haemorrhages

REFERENCES

1 Colbourne, M J , Edington, G M & Hughes, M H. (1950) *Trans R Soc trop Med* , 44, 271.

2 Gosden, M & Reid, J D (1948) *Trans R Soc trop Med* , 41, 637

3 Woodruff, A W. *This Report*, p 293

CALCIUM AND MAGNESIUM IN THE SERA OF DAKAR AFRICANS

by

J. Linhard, F. Busson and P Giraud

The reaction between alkaline earth metals and polycarboxyl amino-acids has been used as a basis for the estimation of calcium and magnesium by Schwarzenbach and his co-workers The results of their research appeared in a series of papers in Helvetica Chimica Acta in 1947-8 Their procedure has since been applied to biological materials

Details of the method for estimating calcium which was used in this study are given in a paper by Elliot[2] Murexide* (ammonium purpurate) at pH 12 was chosen as the indicator

For magnesium estimation the procedure of Orange and Rhein[4] was adapted as a macro-method, but gum arabic (purified by precipitation three times in ethyl alcohol) in a 1/1000 aqueous solution was used as a stabilizer Maximum absorption was found to be at 540mμ, all measurements were made on a Beckman DU spectrophotometer at that wavelength

Table I

Estimation of serum calcium (mg per 100 ml serum) in blood of 317 apparently healthy young adults

	256 African men of different races living in Dakar	37 African women from Popenguine	24 Europeans living in Dakar
Mean value	9 24	9 07	9 89
Standard deviation	0 427	0 787	
No of subjects with a value below European norm of 10	251	35	14
No of subjects with a value above European norm	5	2	10

*We wish to thank the Schuylkill Laboratories (Philadelphia) and the Hagan Corporation (Pittsburgh) for sending us the first samples of Murexide This product is now obtainable generally

Table 2

Estimation of serum magnesium (mg per 100 ml serum) in blood of 105 apparently healthy young men, at the end of the rainy season 1952

	95 African men of different races living in Dakar	10 European men living in Dakar
Mean value	2 11	2 15
Standard deviation	0 250	

Among the African subjects it was not possible to establish relationships between differences in diet on the one hand, and profession or racial sub-division on the other

The distributions of calcium and magnesium in the sera of the male Africans studied followed the normal curve of error (figures 1 and 2) and there is no reason to believe that, had the samples been large enough, the distribution of values in the other two groups would have deviated from it

This study confirms the conclusions reached by Auffret and Tanguy[1] and Gasq[3] who found that during the rainy season the serum calcium level of the Dakar African is significantly below that of the European Their techniques were difficult and, unfortunately, limited them to a small number of subjects However, although a tetanic tendency is sometimes observable and Chvostek's sign appears frequently, we, unlike Auffret and Tanguy, do not propose to speak of calcium deficiency but will content ourselves with observing that we should expect about 95 per cent of the male Dakar Africans to have during the rainy season a serum calcium level of between 8 4 and 10 0mg per 100 ml serum Judging from the figures we have obtained on 37 African subjects, a similar level may be expected in African women The calcium level of Europeans is very similar in Dakar to that in France

The small standard deviation of the serum magnesium values is in conformity with what is already known of their constancy Variations in other elements of the serum, such as phosphates and proteins, do not affect the magnesium level as they do the calcium level The magnesium level among Dakar Africans falls within the European norms which are generally considered to be from 18 to 28mg per 100 ml serum The mean value does not differ significantly from that of the ten European subjects studied in Dakar

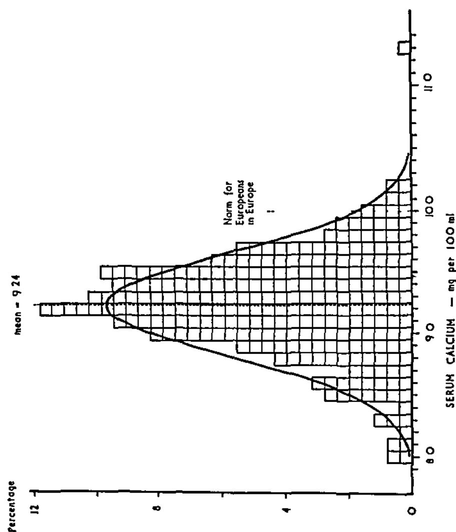


Fig 1 Frequency distribution of calcium in the sera of 258 male Africans

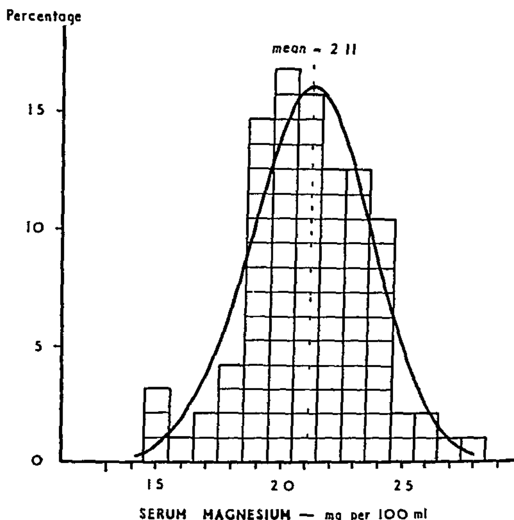


Fig 2 Frequency distribution of magnesium in the sera of 95 male Africans

REFERENCES

1 Auffret, C & Tanguy, F *(1946) Organisme d'Enquête pour l'etude Anthropologique des populations indigenes de l'AOF, Report 2 168*

2 Elliott, W *(1952) J biol Chem* 197, *641*

3 Gasq, M *(1947) Organisme d'Enquête pour l'étude Anthropologique des populations indigenes de l'AOF, Report 3, 255*

4 Orange, M & Rhein, H *(1951) J biol Chem* , 189, *379*

DISCUSSION

Professor BIGWOOD insisted that care be taken in assessing birth weight measurements. During the acute food shortage in Belgium in 1941-2 the average figure for weight at birth showed a fall compared with pre-war, but on closer examination it was found that the figure for children born *at full term* was, in fact, not lower than normal Was there any certain way of telling whether the African child with a low birth weight was in fact born at full term? In the Belgian Congo it was very difficult to obtain accurate information in that respect. It might be that the 'small' babies were actually slightly premature

With regard to the xanthine oxidase, he observed that as measured by reduction of methylene blue it was present in very fresh cow's milk but rapidly disappeared. It could be used as a test of the freshness (absence of bacteria) of the milk. It had no significance for the young offspring.

Professor PLATT observed that the method of estimation of xanthine oxidase which he used was not open to the objection that the observations could be explained by the presence of micro-organisms

Professor BIGWOOD went on to say that the congenital abnormalities which figured in Miss Rendle-Short's analyses (page 290) could be exactly reproduced in experimental animals from riboflavin deficiency during foetal development[1]

Professor MONCRIEFF wondered what weight standard should be adopted for distinguishing between the premature and the full term African baby The 2,500 gram or 7 to 7½ lb norm in Europe for a full term baby might not correspond to the actual norm in Africa The figures for still births, neonatal deaths and premature births at Mulago Hospital, given by Miss Rendle-Short, clearly indicated that the prenatal diet was hopelessly inadequate Nevertheless, the death rate among babies born prematurely was satisfactorily low It suggested that the heat and humidity of a tropical climate formed a perfect incubator

All the evidence went to show that breast milk was the best source of protein for the baby, but it was important to find out for exactly how long the flow remained constant in quality and quantity The figures were conflicting, though it was apparent that the protein content of breast milk remained good even when the mother was near starvation The best solution seemed to be to persuade the African mother to revert to the feeding pattern which prevailed before the arrival of the missions, as it might be that insistence on early weaning had deprived the infant of an irreplaceable source of protein There was no evidence for the argument that prolonged breast feeding of the baby harmed the mother, provided that she did not become pregnant again.

Dr CLEMENTS thought it might interest the Conference to know that among the Melanesians - one of the few groups in the world still unaffected by what might be called 'western civilization' - there was no sign of kwashiorkor Breast feeding went on up to three years Sheila MacDonald (working on behalf of the South Pacific Commission) had estimated that the milk obtained by self-demand feeding varied between 6 and 18 oz. (170and 510g) a day in the second year of life and between 5 and 10 oz (142 and 284g) in the third year Supplementary feeding was almost universal from the first month, and consisted of the easily digested food common to the community, or of other food pre-masticated by the mother As soon as it was able to grasp food from the family pot, the child was allowed to eat it Gastro-enteritis was uncommon

Dr WATERLOW said that not everything was known about lactation Dr Cicely Williams had cited cases of suckling by the grandmother

Dr TROWELL added that breast feeding by virgins and non-pregnant grandmothers was not unknown Indeed, the signs were that there was an endocrine pattern peculiar to certain African peoples, the adolescent increase in growth was another aspect At the other end of the scale, it might well be that there was premature senility.

Professor DAVIES agreed with the point made by Professor Bigwood when he had questioned whether an African infant at birth was full term To him, a so-called 'full term African child' looked more like a 6 or 7 month child

Professor FRONTALI, commenting on a point that Professor Bigwood had raised during the preceding session when he had mentioned the incidence of prematurity as a cause of low birth weight averages during the war, observed that this might, of course, be a source of error With the purpose of avoiding this error, he and his collaborators had studied during the last war the weights of 27,000 newborn infants at full term, excluding all the cases where the duration of pregnancy could not be definitely ascertained For every year an equal proportion of new-borns of the first, second, third, etc , pregnancy was utilized These weights were divided, according to the years considered, by serializing them in classes of 100g intervals between 2,500 and 4,500g The mode of the binomial curve which resulted (that is, the class of weights having the maximum of frequency) varied in pre-war years between 3,300 and 3,500g while in the war period, especially after 1943, it fell to between 2,900 and 3,000g The curve of the modes was in this sense very indicative The intake of proteins by pregnant women during the war could be as low as 54 to 60g instead of the recommended 85g per day

A second point referred to the influence of mothers' rations low in proteins and other nutrients on not only the secreted quantity but also on the quality of breast milk. The composition of milk from 50 underfed mothers obtained by Finizio was compared with the composition

of the milk of the same women after they had been for two weeks on a normal diet In Germany during the first world war, Lederer had observed a reduction of the calories in the milk of underfed women

This underlined the point emphasized that morning by Professor Platt, who preferred to supplement the feeding of the mother rather than the ration of the baby In fact this was done in Italy in the maternal refectories of the 'Opera Nazionale' for maternity and infancy (O N M.I.)

But even so, towards six months of age, the growth of infants at the breast of hard working women frequently comes to a stop, and their ration has to be supplemented under the supervision of a child welfare clinic if one wants to prevent precocious weaning and prevalent starchy food diet

REFERENCE

1 Warkany, J (1944) *J Pediat*, 25, *476*

TREATMENT OF KWASHIORKOR AT MULAGO*

by

R. F. A. Dean

The conception of kwashiorkor as a protein-deficiency disease has led to treatment with diets rich in protein The diets which we have used will be described after the principles of treatment have been outlined and some of the difficulties involved have been described

Dietary treatment has to be designed with three classes of pathological change in view (a) the changes in serum proteins and enzymes, the correction of which seems to call for large amounts of protein, (b) the fatty liver, which suggests the need for lipotropic agents, and (c) the changes in the intestinal tract, which greatly reduce the efficiency of the processes of digestion and indicate that it is essential to give foods which are easily assimilated

The first principle of treatment seems to be to give as much protein as possible and, as we do not know what amino-acids are specifically needed, it is as well to use a protein, or mixture of proteins, of high biological value Probably the protein should be rich in methionine, because vegetarian diets of the kind on which children seem to contract kwashiorkor are likely to be short of the amino-acid Methionine is known to be lipotropic It is concerned in the formation of choline, which is also lipotropic Perhaps the diet should contain an ample supply to allow for the possibility that normal synthesis may be impaired. Cyanocobalamin (vitamin B_{12}) must be added, not merely because it too is lipotropic but also because it may help in transmethylation On purely empirical grounds, it seems reasonable to add it for the same reason that we suggested adding methionine - because so many of the home diets of these children contain very little. Our knowledge on this point is incomplete and it is possible that there are unsuspected sources of the vitamin, such as foods which are eaten after they have been acted on by moulds There are, however, no certain vegetarian sources and I think it is necessary to ensure an adequate supply

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* The cases of kwashiorkor mentioned in this paper were considered to have no important complicating disease Thompson, working at Mulago, has recently extended our preliminary observations on the use of soya diets by attempting the treatment of an unselected series of 43 children, admitted with the diagnosis of kwashiorkor One-third of these children had some active complication.

The records of five children could not be used, for various reasons Of the remaining 38 children, 22 were deemed to progress satisfactorily on the soya diet, nine progressed poorly, but did better on a milk protein diet, and seven died despite change to the milk diet

In the early trials we paid no attention to the calorie value of the diet On the basis of experience with feeding moderately malnourished German children[1], a diet containing at least 135 Calories per kilogram body weight was considered necessary for children who had kwashiorkor Later experience showed that it was difficult to get the children to take a diet of such high calorie value and that the need for increasing the energy content of the diet became more important in the stages of recovery after the disease processes had been arrested.

It was difficult to find suitable foods to supply additional calories Fat, at least as milk fat, was badly tolerated Out of the locally available carbohydrate foods, sweet banana was selected as being the best[2]

After assessing the results of treatment of over a hundred cases of kwashiorkor, it was decided that a minimum of 50g protein daily is needed for the cure of fairly severe cases The amounts of various foods, some of which have been used in the treatment of kwashiorkor, providing 50g of protein are given in table 1, which includes estimates of methionine, choline and cyanocobalamin. Some of the foods containing 50g protein are too bulky when prepared in a form acceptable to a child acutely ill with kwashiorkor In this respect, milk seems to be the most suitable of the animal foods, peanuts and soya are the best of the plant foods but cereals are unpractical

Table I

Amounts of various foods yielding 50g protein and their methionine, choline and cyanocobalamin (vitamin B_{12}) content

	Amount of food (g)	Methionine (g/50g protein)	Choline (mg/50g protein)	Cyancobalamin (µg/50g protein)
Meat (beef muscle)	250	1 6	240	15
Fish	250	1 7	210	18
Liver	310	1 6	1,650	310
Cows' milk: dried whole	190	1 7	204	15
Cows' milk: dried skimmed	150	1 7	240	15
Maize meal	625	1 5	260	0
White wheat flour	500	0 5	260	0
Rice	830	1 7	730	0
Peanuts (groundnuts)	180	0 6	300	0
Soya bean	125			
Soya (Mulago preparation)	300	0 8	425	0

In view of the general agreement that cow's milk, suitably modified, is the food of choice for treatment of kwashiorkor, it might well be used as a standard by which to judge other foods for this purpose Meat and fish appear to be of similar value to milk If choline and cyanocobalamin are all that is required in treatment, then small doses of liver can be effective Our own experience and that of others has been that treatment with liver is not outstandingly successful.

There are side effects of giving the sick child the amounts of food shown in table 1 For example, 190g of full cream dried milk contains about 55g fat, and much less than this amount of milk fat usually causes intense diarrhoea, 150g of dried skimmed milk contains 75g lactose and this often has the same effect

There is likely to be considerable wastage of any food given owing to imperfect digestion and absorption and probably to imperfect utilization The degree of wastage may vary with the condition of the child and with the particular enzyme systems which are most profoundly affected It is possible that one child may need methionine, or some other amino-acid, more than anything else, another may need choline and another, who needs choline, may be unable to hydrolyse lecithin Yet another may have acquired a store of cyanocobalamin and not need an extra supply Whilst our knowledge of the disease is incomplete, all we can do is to use the foods that seem the most appropriate in the largest amounts which the child can be induced to take When we know more about the disease, we may be able to recognize the circumstances that demand the variations of treatment.

It is very difficult to assess the value of any therapeutic agent in the treatment of kwashiorkor Results of attempts to show the effect of methionine have been disappointing Results of the addition of different amounts of cyanocobalamin to various diets are so far inconclusive

Since the results of the use of the diets based on soya bean preparations were published[2] some modification of the preparations has been made Soya beans are cooked for eight to ten hours and not autoclaved Uncooked sweet banana* is always used instead of plantain, which seems to be less digestible and requires cooking Table 1 shows that 300g of our usual preparation of soya provides only half of what seems to be the requisite amount of methionine It has ample choline which is, of course, derived from the soya lecithins Like all plant materials, it is not accompanied by cyanocobalamin

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*It is convenient to recognize two main species of cultivated Eumusa. *Musa paradisiaca*, for which the term 'plantain' might be reserved, is eaten as a vegetable and is usually cooked. *Musa sapientum*, to which the term 'banana' might be applied, is sweet and usually eaten raw as a fruit. In the West Indies the term 'plantain' is applied only to sorts eaten cooked In the Eastern tropics, however, this distinction is not generally recognized, both 'cooking' and 'table' sorts being commonly known as 'plantains' - *Ed*

We are still unable to say exactly the extent to which the soya-banana diets will replace milk protein diets but, on the whole, the good results obtained at first have been sustained In the first place the diets were only given to children who were not seriously ill and with them we had no trouble at all Lately, on treating more severe cases, we have had occasional trouble from what appears to be a large residue in the stomach several hours after a feed If vomiting occurs on any diet, the stomach is usually ashed out before giving the next feed Occasionally in a very ill child there seems to be a breakdown in the mechanism for passing food out of the stomach Twice at post-mortem examination we have found a cast of solidified milk in the stomach, and that has made us careful A few children given the soya diet have vomited and had large residues and we thought it best to change them to a milk diet The cause of the delay in the emptying of the stomach and of the vomiting may have lain in the considerable amount of fat given, about 25g daily As already stated, milk fat provoked diarrhoea It was expected that the soya fat would do the same It did not, and it is possible that the good tolerance was due to the high proportion of short-chain fatty acids in the soya fat, which might have been particularly easy for the children to absorb Faced with these signs of a different kind of intolerance, we are hoping to begin shortly trials of a defatted soya flour

The soya-banana diet seems to be very satisfactory in the treatment of moderately severe kwashiorkor The following is an illustrative case note

Mawanda, a child of the Baganda tribe, was two years old when admitted to hospital For seven months he had been living with his grandmother, who was able to give us an exceptionally good history He had been entirely breast fed for only three months and had been weaned at one year onto the usual diet of plantain and s eet potatoes, with very occasional meat but no milk. He had been ailing for about four months For three months it had been noticed that the skin was paler and that the hair was losing its colour One month before admission the legs had begun to swell and the skin had started to peel The appetite was poor, especially for solids, and there had been some diarrhoea

The child was miserable and small, weighing only 7 0kg (15½lb) despite moderate oedema of the feet and legs The skin was pale and the hair fine, straight and brown There were fissures on the upper lip and at the corners of the mouth, a denuded patch of skin on the left buttock and weeping areas on the groins There were purple patches on the thighs and perineum. The liver edge was palpable just below the costal margin the spleen was not palpable The red blood cell count was only 2 9 millions/cu mm and the haemoglobin 10 1g/100 ml There were a few malarial parasites in the blood The temperature was normal The total serum proteins were 4.9g/100ml, the blood urea 16 3 mg/100 ml the total cholesterol 60mg/100 ml and the ratio of free to total cholesterol 0 75.

Throughout treatment the diet included 300g of our soya preparation, with banana and sugar, and enough of a multivitamin mixture to provide, among the rest, about 15μg cyanocobalamin - a fermentation product and therefore not pure The whole diet provided about 55g

protein, 1 3g methionine and 450mg choline, and its caloric value was approximately 1,500 - or 140 Calories/kg body weight The appetite was not uniformly good and at one important point became downright bad

The child made a very good recovery, the skin healing and the oedema being entirely lost in the first ten days He then started to regain weight, which had increased by nearly 1 0kg when he developed an attack of malaria, which was of short duration The clinical condition continued to improve but very little weight was gained up to the 35th day, when he was discharged The total serum proteins had reached 8 0g/100ml, urea 44mg/100ml and total cholesterol 160mg/100ml, with a ratio of free to total cholesterol of only 0 4 He looked extremely well

During treatment, two four-day balance studies were made, the results of which are shown in table 2 In the second period, after 25 days treatment, the appetite was poor and the intake of nitrogen was only half that intended The interpretation is therefore uncertain but there was presumably a great difference in the proportion of dietary nitrogen metabolized in the two periods because the proportion of faecal nitrogen fell so greatly in the second The absorption of nitrogen increased from 72 to 79 per cent, and that of fat from 86 to 96 per cent The amounts of fat in the diet were considerable - 25g daily in the first period and 15g in the second - but there was no diarrhoea The stools were, in fact, remarkably well formed towards the end of treatment and were unusual in being dark in colour, contained very little undigested material and had a normal faecal odour.

The results of balance studies on two other children having the soya-banana diet are included in table 2 Both were very well at the time When the soya in the diet of Kisule was replaced by skimmed milk, the nitrogen absorption rose to 88 per cent and the ratio of urinary to faecal nitrogen was extremely high The diet was virtually fat-free It seems likely from this result that the utilization of the milk diets will be found to be better than that of the soya diets, at least if soya beans are used without removing their fat Ways will have to be found of making the soya more digestible We are fairly sure that our method of preparation destroys the trypsin inhibitor but it is possible that some other method might give better results We have the impression that there may still be a small gap to be bridged between the milk and the soya diets In the acute case a great deal depends on the food intake in the first days of treatment We do not hesitate to use gavage if necessary On the whole there is less reluctance in these critical days to take the milk diets than to take the soya diets Whether this is a matter of taste or of some other factor which determines appetite cannot at present be decided After the first few days, one diet is usually taken as readily as the other and the results are almost identical Oedema may, however, be lost a little quicker when the milk diet is given and weight may be regained a little faster

Table 2

Nitrogen and fat balances 4-day periods

Name	Condition	Diet	Nitrogen						Fat	
			Food (g)	Urine (g)	Faeces (g)	Urine N / Faecal N	Absorption (%)	Daily balance (g)	Food (g)	Absorption (%)
Mawanda	Acute kwashiorkor	Soya and banana	25 6	6 8	7 2	0 9	72	+ 2 9	96 0	86
"	After 25 days treatment	"	12 6	7 7	2 6	3 1	79	+ 0 6	62 5	96
Bandiho	Recovering kwashiorkor	"	26 6	11 4	6 4	1 8	79	+ 2 2	116 2	94
Kisule	Polio convalescent	"	28 2	15 7	5 6	2 8	80	+ 1 7	117 0	97
"		Skimmed milk & banana	23 9	13 6	2 8	4 8	88	+ 1 9		

$$\text{Absorption} = \frac{\text{Food N} - \text{Faecal N}}{\text{Food N}} \times 100$$

The soya preparation has been used regularly as a supplement to the usual diet of patients with the common diseases - mostly pneumonia and malaria, accompanied by some degree of kwashiorkor It has been incorporated in a simple maize porridge and taken readily by the children, who appear to thrive on it It seems to be a satisfactory source of protein and calories It is certainly cheap and in its preparation no special apparatus is needed

REFERENCES

1 Dean, R. F. A. (1953) *Spec Rep Ser med Res Coun ,Lond , No 275*

2 Dean, R. F. A. (1953) *Brit med J* , ii, 791

PREVENTION OF KWASHIORKOR IN CHILDREN

by

H. C. Trowell

Value of a campaign to prevent a specific disease

The prevention of malnutrition can be approached in two ways one may advocate certain nutritional standards or one may try to suppress certain specific diseases Both approaches are desirable and are, indeed, complementary, but the former is apt to prove disappointing. There is an impression, however, even among doctors that nutritional standards have been set impossibly high, that when considerably reduced no obvious disease results Also people may be discouraged if they find they cannot afford the milk, fruit and vegetables advocated. This approach fails completely with backward people who are both poor in their pockets and limited in their intelligence and education We should firstly attempt to ensure that the diet of poor people has an adequate calorie and protein content, and contains a wide variety of foods

With regard to protein inadequacy causing kwashiorkor, Brock and Autret[1] have remarked that 'a wide and general appraisal of its nature and relationships suggests that it is the most serious and widespread nutritional disorder known to medical and nutritional science' The task now is to help doctors, nurses and the laity to recognize kwashiorkor and to insist on action both curative and preventive Kwashiorkor is a most serious disorder which it is now possible to demonstrate is always associated with diets low in protein calorie ratio and is prevented by diets high in the proportion of protein, or, during the first few months of life, by the exclusive use of breast milk of normal composition

There are many who prefer to use the term 'malnutrition', and others refer to 'deficiency disease' or 'nutritional dystrophy' There are yet others who prefer to list, but leave almost unrelated, a hodge-podge of ill-assorted and unrelated signs ascribed largely to vitamin deficiency, many of which are of very doubtful validity Very serious objection must be entertained against the use of these methods and terms, for they beg the question concerning the type of malnutrition present It is quite unsatisfactory to make the vague diagnosis 'tropical fever' when the patient is suffering from malaria No one is allowed to be so slip-shod in the diagnosis of an infectious disease as to compile merely a category of signs and refuse eventually to face the fundamental basis of pathology or to consider that a mixture of penicillin, aureomycin and quinine would help most cases The term 'malnutrition' is a confession of ignorance No one can prevent or even cure 'malnutrition', and no one can prevent a syndrome

The soya preparation has been used regularly as a supplement to the usual diet of patients with the common diseases - mostly pneumonia and malaria, accompanied by some degree of kwashiorkor It has been incorporated in a simple maize porridge and taken readily by the children, who appear to thrive on it It seems to be a satisfactory source of protein and calories It is certainly cheap and in its preparation no special apparatus is needed

REFERENCES

1 Dean, R. F. A. (1953) *Spec Rep Ser med Res Coun ,Lond.,* No 275

2 Dean, R. F. A. (1953) *Brit med J* , II, 791

possibly caused it. There followed communications from Budapest, New Delhi, Athens, Barcelona, Istanbul, Madras, Johannesburg, Manila and Pretoria Two of these referred *specifically* to kwashiorkor by name, most employed some other term, such as 'alimentary dystrophy', but it was clear that they were almost all describing some cases of the same disease There was still some confusion with marasmus and the infectious diarrhoeas of infancy, but almost all contributors described many cases which had had oedema in the second year of life together, in certain cases, with a pellagrous dermatosis]

(e) Nursing and health personnel should be informed by appropriate means

(f) The public should be informed by films, articles in the newspapers, booklets purchasable in ordinary shops and at antenatal and child welfare clinics, and leaflets distributed and purchasable in children's hospital wards and in women's institutions

Infant welfare clinics

It is in the infant welfare clinic that ideas will be clarified concerning methods designed to prevent kwashiorkor and to diagnose, differentiate and cure early cases[11] The number of these clinics should be greatly increased It is impossible to discuss the methods in any detail, as these will differ from one area to another, but certain fundamental principles can be discussed Kwashiorkor is only common in culturally retarded communities and in socially depressed classes among the women in these groups it is important to encourage lactation for a year or more complete weaning from the breast may be possible at six months if cow's milk can be purchased, but this is often impossible for those who are poor After one year very few women can form enough breast milk to supply adequately the large calorie and protein requirement of the growing infant and by then, if not before, the amount declines Complete weaning has, therefore, been advised in Uganda when the child is one year old, and both the mother and child must learn that mixed feeding must then be made to succeed It is uncertain how far this rests on any scientific basis and much more research is needed concerning the age at which infants, on different diets, can grow well without any milk from the mother or from the cow, and concerning the quantity and quality of the breast milk from six months to two years or more

Even among African peasants some regularity in breast feeding should be encouraged from birth, although this should not follow clock time too slavishly, yet these feeds may, with advantage, be spaced throughout the hours of daylight, allowing other household duties to proceed in between Mixed feeding should commence at six months but should be forbidden before this age The tendency has been to choose soft foods, various starchy paps, cooked plantains, potatoes or yams, or soft gruels, and to avoid the tougher foods, beans, peas, groundnuts, meat and fish This is exactly the wrong emphasis if protein is to be increased and kwashiorkor prevented The problem is how to prepare tougher foods so that they are suitable for a young child Relatively simple procedures of prolonged boiling, mashing, pounding and mincing will render food suitable for a child of eighteen months or over, but from six months to a year-and-a-half some sieving is probably required Simple sieves made of mosquito netting or tins with holes in the bottom can be employed

If it is asked how rickets, scurvy and pellagra have been prevented, the answer is the same for all three Very advanced cases of the disease were first of all recognized by a few doctors who thought they were describing a new disease, considerable difficulties were experienced in defining the clinical picture, obtaining agreement over terminology, and in clarifying the relationship to infection and in establishing the pathology and finally the biochemistry of the disease While this was proceeding, views on aetiology were clarified until a point was reached when all the evidence began to point one way Experiments in animals helped considerably but it was seldom possible to reproduce the disease in a large number of human volunteers, so that some workers remained unconvinced concerning the cause of the condition Gradually informed therapy became much more effective and this, more than anything else, clinched the main aspects of the aetiology which was, however, seldom completely and scientifically proved in human beings in a fully controlled experiment Once a large measure of agreement had been obtained about the essential cause of the disease a demand arose, quite rightly, for the illness to be prevented The prevention of kwashiorkor will lie along similar lines

It is quite certain that the vast majority of cases of kwashiorkor are not diagnosed as such, and very careful steps to spread the knowledge of this disease among the medical profession are essential in its prevention Very few textbooks contain a description of the disease and few doctors coming to or being trained in the tropics receive adequate instruction in this disease

Publicity among doctors, nurses and the general public

The following steps are recommended

(a) A short note on the disease should be sent to the authors of standard textbooks of general medicine
(b) A more detailed statement should be sent to the authors of medical textbooks of paediatrics, nutritional diseases and tropical medicine
(c) Medical journals, preferably those which circulate most widely among the members of the profession, should give a short description of the disease as a contributed article
(d) An attempt should be made at some future International Congress of Paediatrics to have a sectional meeting dealing specifically with kwashiorkor [The confusion in thought which exists is reflected at recent congresses The Fifth Congress at New York in 1947[4] contained three separate groups of references to kwashiorkor (i) at the first plenary session on nutrition there were contributions by speakers from South Africa, and India (ii) at the sectional meeting on 'Avitaminosis' there was one full account of kwashiorkor from Egypt and another short description from Mexico (iii) Veghelyi's contribution on pancreatic function in kwashiorkor (called nutritional oedema) in Hungary was given at yet another section of the congress Every speaker called the disease by a different name The *Sixth International Congress of* Paediatrics at Zurich in 1950[9] fared somewhat better In its seventh section on 'Diarrhoeal Diseases and Dystrophies', there was a sub-section dealing with those due to *malnutrition and under-nourishment* this suggested that the diarrhoea invariably accompanied kwashiorkor and

of clinically manifest kwashiorkor[10, 11]. Others have noted the same retardation of growth in African infants, almost always commencing in the second six months of life[7, 8] In any survey of children at this age the most important question is how far in any individual case retardation of growth, or any of the signs of kwashiorkor, are to be ascribed to general undernutrition (calorie deficiency), selective aspects of malnutrition such as kwashiorkor (protein deficiency), vitamin A deficiency and so forth, or to infections, or to a combination of all these defects

In the solution of the problems raised by protein inadequacy the co-operation of officials and others engaged in agriculture, in animal husbandry, in fisheries and in administration is essential, and it would be a stimulus if the regional surveys of kwashiorkor were correlated with an estimate of the foods grown and eaten in the area concerned. A considerable variation in the protein intake would be found, depending largely on the cereals and staples grown, and on the consumption of peas, beans and groundnuts It is considered probable that the incidence of kwashiorkor is high in areas having a low mean protein production and consumption, but it is necessary to consider the problem district by district and to estimate how much variation occurs among various social classes and individual families Individual dietary surveys might well be attempted but their limitations and inaccuracies should be understood

It is also submitted that it is necessary to pilot a research scheme specifically to investigate the economic and sociological aspects of kwashiorkor since this is certainly one of the social diseases Applications should be sponsored for specific research fellowships into this aspect of the problem, and one or two pilot schemes could start in Africa, being conducted under the auspices of an accredited institute for social research, or a university

Research into kwashiorkor and allied problems

It is certain that the problem of kwashiorkor is far from solved, it is uncertain how far various foods protect against this disease, how far vegetable protein can replace animal protein, how far accessory protein factors such as cyanocobalamin (vitamin B_{12}) play a part, how far lack of certain amino-acids such as lysine or methionine constitutes the principal deficiencies, and how far irreversible sequelae may occur These and a host of allied problems[5, 6] will only be solved if specialized workers, techniques, institutions, wards and clinics can be devoted to the problem. It would be a great advantage if they were situated near medical schools where other aspects of the problem are being investigated, and in connection with colleges where those versed in agriculture, animal husbandry and the social sciences are also present This is a problem which is knit into the very pattern of the life of culturally retarded and socially depressed classes, it is part of the pattern of backwardness, of poverty and of over-population

The question arises whether in addition any special food should be purchased for young children. It appears probable that, even in Africa, nothing will prove so popular as milk from the cow or goat It has a *psychological appeal and a prestige* that cannot be gainsaid. Since few Africans can purchase much whole cow's milk, especially in towns, everything must be done to popularize the sale of unsubsidized skimmed milk powder in all stores, clinics, hospitals and schools It should be marketed and labelled as *'Milk Protein' since the term* 'skimmed milk' has an offensive implication No public authority, be it a municipality, a district or a country, can be considered as having discharged its obligations unless dried skimmed milk is available and on sale at many places in small amounts in *cartons, wrappers* or tins, for those who are in a position to purchase an unsubsidized product

Is there any place for a special preparation of groundnuts, sunflower seeds or soya beans? A case could be made out for pursuing two lines, firstly, encouraging peasants who grow groundnuts and ordinary beans to prepare a thick soup for children over six months of age and, secondly, finding out how far mothers at child welfare clinics in more advanced centres can be persuaded to purchase commercial preparations of soya bean These can be obtained as a homogenized paste, fully cooked, and with the trypsin inhibitor destroyed, and should cost about one quarter to one half of the price of skimmed milk powder They remain well preserved and palatable for many days even after the tin or bottle is opened A few teaspoonfuls can be given each day to the child and thus supplement a low protein intake[2,3]

Local surveys in co-operation with Departments of Agriculture and Animal Husbandry

It is considered that the first stage in the prevention of kwashiorkor in any country is widespread publicity among the medical and nursing professions and health services, the second is the detailed study of methods of prevention in child welfare clinics, and the third stage starts with an attempt to survey, district by district, the incidence of the disease and to study its relationship to the production and consumption of food Only thus will the seriousness of the problem become apparent and be related to the work of those who can solve the problem It is important that the survey *of the incidence of kwashiorkor should be conducted* by someone well instructed in the recognition of severe and mild states of the disease In those countries where few or no cases of severe kwashiorkor occur, it is manifest that no progress can be made until the status of the milder cases is settled by a controlled clinical, biochemical and pathological assessment of the response to increased amounts of protein Definitions of mild kwashiorkor and severe kwashiorkor have been submitted (see page 351), and it is hoped that a large measure of agreement can be reached so that it will be possible to compare the figures obtained by one worker *with those given by another* It is the opinion of some in Kampala that a very large proportion, if not the majority, of African children near that town pass through a phase

5 Holmes, E. G. & Gee, F. L. *(1951) E Afr med J*, 28, 297

6 Holmes, E. G., Stanier, M. W., Semambo, Y. B. & Jones, E. R. *(1951) Trans R Soc trop Med Hyg*, 45, 371

7 Jelliffe, D. B. *(1952) Trans R Soc trop Med Hyg*, 46, 13

8 Meyers, R. *(1951) Ann Soc belge Med trop*, 31, 59

9 Sixth International Congress of Pediatrics, Zurich *(1950) Summaries of Communications*, 128-35, 341-3

10 Trowell, H. C. *(1950) Nut Rev*, 8, 161

11 Welbourn, H. F. *(1952) E Afr med J*, 29, 131

Summary

It is emphasized that success is more likely to attend a campaign to prevent a specific disease than one designed to overcome a vague concept of malnutrition or one which advocates certain optimal dietary requirements The first of these directs attention to a disease and calls for immediate action It is considered that there are sufficient reports to define a specific disease, kwashiorkor, and to say whether a child is suffering severely or mildly from the affection The prevention of a disease is only possible when the disease has been recognized by the medical profession, allied health personnel and the general public, most of whom at the present time have barely heard of kwashiorkor Methods of publicity are discussed. Local surveys of the incidence of severe and mild kwashiorkor are required in many territories, but must be undertaken only by those who have been trained to recognize the disease These surveys should be correlated with an estimate of the food taken by various age groups and social classes at different times of the year Co-operation with those engaged in agriculture and in veterinary science is essential, for the prevention of the disease depends on the production of more protein and its diversion to the vulnerable groups of young children and lactating and pregnant women Prevention is doubtless a very complex question, having many social, agricultural and economic aspects The fundamental knowledge of the cure and prevention of this disease very largely, if not entirely, by vegetable protein has been accumulated both in Europe[3] and Africa, it remains to apply this knowledge This is likely to prove extremely difficult, for the problem is rooted and grounded in the very conditions of the country and the life of the people Special research units are required to experiment with measures designed to prevent and cure the disease Protein deficiency affects adults not only as acute episodes but as a recurrent theme, probably producing many unexpected diseases as well as being the root of the problem of kwashiorkor in childhood Protein deficiency is a world problem which will become more severe as population increases

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REFERENCES

1 Brock, J. F. & Autret, M (1952) *Bull World (Hlth) Org*, 5, 1

2 Dean, R. F. A (1951) *Brit J Nutr*, 5, 269

3 Dean, R. F. A. (1953) *Spec Rep Ser med Res Coun, Lond*, No 275

4 Fifth International Congress of Pediatrics, New York, (1947) *Acta paediat* 36, 83, 110, 128, 316, 329, 483

it was nutritional in origin, caused by damage to the liver There was, as Professor Davies had said, evidence of a continuous pattern persisting into adult life

Professor FRONTALI commented on the treatment of patients suffering from starchy food dystrophy A certain number of deaths were accounted for by a cardiac lesion which might occur in the course of plasma transfusion On X-ray examination the right side of the heart was seen to be enlarged and the right side of the heart shadow showed a change in curvature according to the changes in the position of the body The lesion was also characterized by certain alterations in the electrocardiogram He considered these cardiac changes to be due to thiamine deficiency and they could be eliminated in a few hours by injecting cocarboxylase intravenously

Mortality during the first day of hospitalization had been reduced by transfusion of fresh plasma or reconstituted dry plasma. This had been effected without difficulty except in one case when plasma containing anti-Rh bodies was given to a child who was Rh+ Following transfusion, protein milk based on Finkelstein's 'Eiweissmilch' (an Italian product 'Albusol' - a soluble calcium caseinate) was given, and stools were formed within a few days Patients were kept in hospital or under observation in the clinic until a normal distribution of proteins in the plasma was obtained, until this was achieved, the patient was apt to relapse even though he had normal, formed stools and showed an increase in weight An abnormally rapid increase in weight was not a good criterion of recovery because it could be due to retention of water which could be lost again in an intercurrent dyspeptic episode One to two months' treatment was required before a slow, gradual increase in weight and the normal distribution of plasma proteins indicated recovery During or after the second month of treatment, supervision of the patient at a child welfare clinic was still considered necessary In general, complete recovery occurred, this was probably a reason why cirrhosis of the liver was not seen in Italy as a consequence of starchy food dystrophy

DISCUSSION

Dr PATWARDHAN was grateful for the information contained in Dr Dean's paper regarding the inadequacy of a methionine* supplement to a low protein diet in the treatment of kwashiorkor Medical practioners in India sometimes used methionine alone in the belief that it was an adequate supplement in itself, it had now become clear, however, that it was essential to ensure an appropriate combination of all the amino-acids by feeding high protein diets The same held good for cyanocobalamin (vitamin B_{12}) which could not be effective unless protein also was supplied in the diet Emphasis should perhaps be shifted to the basic need for a high protein diet

He wished to hear the views of other clinicians on the subject of the duration of hospitalization of kwashiorkor cases When was a patient considered fit for discharge and was he then assumed to be fully cured? In the public hospitals it was difficult to keep patients longer than was absolutely necessary to effect a clinical cure In kwashiorkor, even when all the clinical signs of the disease had disappeared, the biochemical findings and the histopathological picture of the liver showed the cure still to be incomplete If the child was discharged at this stage, what steps did clinicians take to ensure the maintenance of a nutritious diet at least till such time as the cure was considered complete?

Dr UNDERWOOD GROUND said that in his experience patients could not be retained in hospital longer than 30 days, but he did not consider them 'cured' upon discharge, and it was important to instruct the mother to continue giving the child an adequate diet (The practice of admitting the mother to hospital with the child was an advantage in that respect) Otherwise there would be a relapse and the child would not be brought back to hospital because the mother would consider the doctors to have failed in their treatment

Dr TROWELL referred to Dr Patwardhan's question about discharge from hospital, and 'cure' He had never known a complete cure of severe kwashiorkor unless the patient stayed very many months in hospital the refractoriness of the disease was one of its main features

Professor DAVIES doubted whether severe cases in Uganda were ever completely cured. The disease was continuous if the diet on which it developed remained unchanged, and the majority of those suffering from kwashiorkor in the villages showed a steady degeneration to complete fibrosis in certain internal organs

Professor HOLMES said that the absence of a complete cure was indicated by the presence of an increased concentration of serum globulin Where the blood count rose, the total globulin usually tended to fall The explanation in the case of kwashiorkor might be either that the increase in globulin was due to infection or that

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* see Professor Jacquot's comments, page 217

indispensable amount of animal proteins The measures applied aim at obtaining throughout the Belgian Congo by the end of the ten years (1959) increases in food yields over present production, as shown in table 1

Table I

Percentage increase in production of food crops forecast for decade 1949–59

	per cent
Groundnuts *(Arachis hypogaea)*	192
Kidney beans (*Phaseolus* sp) or Bambara groundnuts *(Voandzeia subterranea)*	33
Grains	25
Maize	51
Butcher meat	100
Fish	300
Milk	800

Upon attainment of the goal, the annual production of proteins from all sources will come to 200,000 tons, making an average of 50g per head per day which will adequately cover requirements According to the same estimates the total production of animal proteins will amount to 27,000 tons, or 7g per head per day According to the estimates of the ten-year programme, the intake of meat and fish, excluding game, at present is only 3 73kg per head per year, or less than 2g of animal protein per head per day

While the programme ought to be fully implemented by 1959, there is no doubt that the benefits will be progressive and that after a period of getting under way, tangible results will be evident from 1955-6 onwards In addition, a social and home economics programme, also contemplated in the ten-year plan, will teach Africans the proper utilization of available foods, while the development of transport facilities and processing industries will ensure a more equitable distribution of foodstuffs in the different parts of the Congo There is hope, therefore, that within a reasonable period, the food situation in the Belgian Congo will be substantially improved

However, there are regions where the Belgian Government has deemed it necessary to take special action without waiting for the results of the ten-year plan Such regions, where signs of protein

SUPPLEMENTARY FEEDING PROGRAMMES IN AFRICA THE EXAMPLE OF THE BELGIAN CONGO

by

M. Autret and R. C Burgess

The supplementary feeding programmes described embody the desire of the Belgian Government to implement the recommendations of the mission on Kwashiorkor[2] and of the report of the Joint FAO/WHO Expert Committee on Nutrition[3] These recommendations are in line with those of the Belgian Congo Health Service and are concerned essentially with the prevention of protein deficiency syndromes Such prevention demands (a) long-range measures concentrating on expansion in the production of animal or vegetable foods rich in proteins, together with educational measures, and (b) emergency measures for the rapid treatment of kwashiorkor and malnutrition As an emergency measure, the use of dried skimmed milk is recommended

Following these recommendations, UNICEF voted a budget for Africa of $2,000,000 of which part is to be allocated for nutrition Belgium and France requested UNICEF aid, the former for the Belgian Congo and Ruanda-Urundi, the latter for French Equatorial Africa The project for the French territory will not be described here as it will not operate till April 1953, and for the moment it only comprises three pilot areas, one urban and two rural districts of Middle Congo and Ubangui-Chari Only the Belgian Congo project, which began in September 1952, will be discussed The zone in which kwashiorkor occurs in the Belgian Congo combines to the maximum the conditions that may be found in the other regions Therefore, it illustrates sufficiently the difficulties to be overcome in implementing a supplementary feeding programme in Central Africa

The distribution of skimmed milk powder is being applied as a temporary emergency measure In regions where milk production will long remain insignificant and where there is no money to buy milk, the ultimate solution should be sought in the utilization of cheap animal or vegetable proteins produced locally FAO has drawn up in this respect a list of suggestions which will be submitted to the Joint FAO/WHO Expert Committee, the results of the excellent research work done at Kampala are also apposite

A ten-year economic and social development programme was drawn up in 1949 by the Belgian Congo Government This programme envisages the extension and improvement of the methods of food crop cultivation, expansion in the raising of meat and barnyard animals, the introduction of a dairy industry, and the intensification of pisciculture The general purpose of these measures is to add proteins to the African's diet by endeavouring to introduce the

indispensable amount of animal proteins The measures applied aim at obtaining throughout the Belgian Congo by the end of the ten years (1959) increases in food yields over present production, as shown in table 1

Table I

Percentage increase in production of food crops forecast for decade 1949-59

	per cent
Groundnuts *(Arachis hypogaea)*	192
Kidney beans (*Phaseolus* sp) or Bambara groundnuts *(Voandzeia subterranea)*	33
Grains	25
Maize	51
Butcher meat	100
Fish	300
Milk	600

Upon attainment of the goal, the annual production of proteins from all sources will come to 200,000 tons, making an average of 60g per head per day which will adequately cover requirements According to the same estimates the total production of animal proteins will amount to 27,000 tons, or 7g per head per day According to the estimates of the ten-year programme, the intake of meat and fish, excluding game, at present is only 3.73kg per head per year, or less than 2g of animal protein per head per day

While the programme ought to be fully implemented by 1959, there is no doubt that the benefits will be progressive and that after a period of getting under way, tangible results will be evident from 1955-6 onwards In addition, a social and home economics programme, also contemplated in the ten-year plan, will teach Africans the proper utilization of available foods, while the development of transport facilities and processing industries will ensure a more equitable distribution of foodstuffs in the different parts of the Congo There is hope, therefore, that within a reasonable period, the food situation in the Belgian Congo will be substantially improved

However, there are regions where the Belgian Government has deemed it necessary to take special action without waiting for the results of the ten-year plan Such regions, where signs of protein

deficiency are frequent, are the Kwango district in Leopoldville Province and the Kasai district, forming the south-western part of the said province Medical and population censuses have shown that this region, with 2,000,000 inhabitants, is the one pre-eminently affected by kwashiorkor The State-supervised medical organization, FOREAMI*, operates in the western part of the Kwango district, which has a population of 700,000, and 6,000 cases of pronounced nutritional deficiencies were treated in 1950, half being typical of kwashiorkor Surveys in some sectors of the Kwango district, made at the time of selecting the recipients for milk allocations, indicated a still higher incidence

The kwashiorkor zone is tableland situated at an average elevation of between 500 and 900 metres (1650 to 3000 ft) with a grassy savanna on very poor sandy soil Crop yields are generally poor, some are bad and are often barely sufficient to ensure the African the indispensable minimum of food or income The main food is cassava, of which the roots and leaves are eaten Maize and millet, beans and peanuts are only meagre additions to the diet. Palm oil, game and fish are seldom obtained As a seasonal or chance protein supplement, caterpillars, locusts and small mammals are sometimes eaten, few or no fruits are grown because the village shifts its location Fuller details may be obtained from the works of Adriaens[1] and Pieraerts[4]

The population numbers about 2,000,000 and it is estimated that ten per cent, consisting mostly of women and children, suffering to a marked extent from protein deficiencies, will benefit from the food distribution plan

The goal of the short-term project is to ensure a supply of dried skimmed milk for a minimum period of three to four years, in order to combat the many cases of protein deficiency in this region, UNICEF will supply milk for two years The recipients are women in the last two months of pregnancy, one- to two-year old infants, and children from two years to school age, i e to seven or eight years (in some regions milk allocations are extended to children up to eleven or twelve years), and, lastly, all cases of M'Buaki† at all ages It will be noted that infants up to one year are not included in this group as the Belgian Government already provides for distribution of milk in the Belgian Congo to those of that age who are not growing satisfactorily Pregnant women, and children over two years of age are given 40g (250c c) daily, and children of one to two years, 20g The amount given to patients with kwashiorkor varies according to the age, weight and condition of the patient Milk is distributed in fluid form only and drunk in the presence of the medical staff However, a carefully supervised distribution of dried milk once a week is contemplated for

* Fonds Reine Elisabeth pour l'Assistance medicale aux Indigènes (Queen Elizabeth Fund for Medical Assistance to Africans)

† see footnote, page 328

children with mild kwashiorkor not requiring hospitalization and unable to come each day to the distribution centre The distribution of biscuits containing up to 20 per cent of dried milk is also envisaged.

The Medical Service is solely responsible for the distribution of milk, which is regarded as a Health Service supply item. There are two methods of distribution, the one used depends upon whether the territory is supplied by FOREAMI or the regular medical service Illustrations are given of each method

A FOREAMI sector covering about half of the Kwango district, comprises five sub-sectors each corresponding more or less to the administrative territorial division Each sub-sector is divided into two or three 'cercles' The administrative territory of Feshi has been specially studied, it has two distribution units an itinerant one in the Feshi 'cercle' and a stationary one in the Bindungi 'cercle'

Table 2

Illustrative district showing division into sector sub-sector and 'cercles' with populations

KWANGO DISTRICT

FOREAMI SECTOR (671,000 inhabitants)

FESHI SUB-SECTOR (83,000 inhabitants)

	FESHI 'cercle'* (itinerant unit)	BINDUNGI 'cercle' (stationary unit)
Number of		
Inhabitants	12,920	39,000
Villages	79	146
Routes	6	
Distribution centres		13
Recipients	7,540	5,084

* total population is 43,111 - the remaining 30,191 constitute a stationary unit

If the itinerant distribution service is to be successful, the milk must be taken to or near to the village, so that the recipients do not have to walk a long distance to get it The 'cercle' is therefore divided into six routes covered successively by the distributors Because of the shortage of personnel, however, distribution is irregular and can only be effected one month out of four or five

In this region, a complete census has been taken of the population, and the application of the project has enabled a preliminary assessment to be made of the incidence of kwashiorkor in a fairly large area Table 3 shows some details of this assessment*

Table 3

Census of Feshi and Bindungi 'cercles' and incidence of M'Buaki

	FESHI 'cercle' (itinerant unit)	BINDUNGI 'cercle' (stationary unit)
Number of villages served by unit	79	146
Population	12,920	39,000
Tribe	Basukus	Bapende
Recipients	7,793	5,084
Pregnant women	102	602
Children under 2 years	1,612	1,698
Children over 2 years	4,723	2,595
Pre-M'Buaki	1,356 (Pre-M'Buaki and M'Buaki)	94
M'Buaki		95

* The high figures for kwashiorkor are not typical of the incidence throughout Africa The prevalence of malnutrition is unusually high in the area under consideration, namely, the territory of Feshi and more especially so in the region populated by the Basukus These figures are based on a broad interpretation of the word 'M'Buaki' and often include cases of pre-M'Buaki while the word 'M'Buaki' covers cases of malnutrition with retardation of growth oedema dyspigmentation, digestive troubles the word 'pre-M'Buaki' covers cases of simple undernourishment with retardation of growth and dyspigmentation without oedema The purpose of the survey was to select cases of malnutrition warranting treatment with dried skimmed milk and this fact should not be overlooked

Distribution by age groups for the M'Buaki cases is not given Our impression at the time of the visit, however, was that the majority of the cases came in the age group over two years

Table 4, in which a very detailed analysis has been made for a group of 24 villages with a population of 4,358, gives 20 bad cases of kwashiorkor, including two extremely serious, while the mild cases were divided as shown

Table 4

Details of recipients and incidence of M'Buaki on Route I, Feshi 'cercle'

	Number	per cent
Number of villages	24	
Number of distribution centres	11	
Population	4,358	
Recipients	1,438	33
Pregnant women	55	
Children under 2 years	189	
M'Buaki	13	6 9
Children 2 to 5 years	729	
M'Buaki	374	51 3
Children 5 to 11 years	465	
M'Buaki	Unknown	

While, in the Feshi territory, distribution is being made to the villages by an itinerant unit, in the rest of the Kwango district served by FOREAMI, distribution is being effected as in the Kasai district through the Health Service, and only in the urban or rural centres where there will be a medical corps, a hospital or dispensary of some size The organization set up by the Kwango medical mission, with head office at Kikwit, is representative of the most usual form of distribution, which obviously reaches less recipients than in the Feshi territory Table 5 illustrates this type of operation

However, if the pilot stage of operations is successful, an extension of distribution to rural hospitals or dispensaries with African orderlies in attendance is contemplated The number of recipients will then be increased from 7,000 to 30,000 for the Kwango Medical Mission sector alone

Table 5

Kwango Medical Mission distribution centres in the kwango district

Population 715,498

Anticipated number of recipients 7,000

Sub-sector	Idiofa	Bulundu	Gungu	Karemba
Population	231,147	199,091	205,547	79,713
Distribution Centres	10	10	11	5

An assessment of the value of the milk supplement will be made, for this purpose the Belgian medical authorities will procure the following data. (a) effect on height and weight, (b) number of kwashiorkor cases, (c) effect on extent of hospitalization and (d) effect on mortality

It is estimated that after the project has been in operation for a year it will be possible to ascertain whether the results are commensurate with the efforts made and the funds invested

The measures described are those envisaged for application throughout the Belgian Congo, obviously the measures will vary from one province to another and from one district to another In some parts much is expected from stockraising, in some from fisheries, and in others from the cultivation of some crop To take a specific example, in the Feshi territory just described, where the soil is poor, great reliance is placed on increasing the production of peanuts and Bambara groundnuts Although millet is not yet widely accepted in the diet, an increase of production is proposed as the crop grows reasonably well It is chiefly on the development of fish pond culture, however, that hopes are set Table 6 shows the achievements already made in this direction

Table 6

Numbers of fish ponds in the Belgian Congo at the end of 1951

Province or Territory	Area		Number of ponds
	Ares*	Acres	
Leopoldville	74,012	1829	21,108
Coquilhatville	5,797	143	160
Eastern	2,002	49	35
Kivu	6,712	166	133
Katanga	5,492	135	220
Kasai	70,082	1732	2,247
TOTAL	164,097	4054	23,903

* 1 are = 100 square metres

Compared with 1950, there is an increase of 9,849 ponds for an area of 67,941 ares (1679 acres) The catch obtained by Africans varies between one and two tons per hectare per year Thus, in 1951 over 2,000 tons of fish were produced, of which 1,800 tons were in the provinces of Leopoldville and Kasai, the kwashiorkor zones The number of ponds in Feshi territory increased from 500 in 1951 to 1,500 in October 1952. It is hoped to have 2,000 in 1953 At the present time, one family out of five in this territory possesses a private fish pond averaging 200 square metres (240 sq yd) in size, which supplies 30kg of fish In this territory, therefore, the solution to the problem of shortage of protein-rich foods will be found mainly in fish, although nowhere, except where milk can be produced cheaply, will the solution be found in a single product Rather, it is towards a compatible combination of different protein foods - vegetable and animal - that production efforts should tend

Table 7

Yields of fish from ponds in two territories of the Kwango district - end of 1951

	Feshi		Gungu	
Number of ponds	477		19,913	
Area - ares	908		64,835	
acres		22		1602
Yield - kg/are	12.5		13.5	
tons/acre		0 50		0 54

As soon as the production of the local protein foods has increased, it will be necessary to introduce these foods into the diet of the mother and infant, first at the distribution centres and later in the home after appropriate education of the Africans In fact, these foods should gradually replace skimmed milk which in this instance is used as an emergency medicine-food The ultimate aim is increased production and better utilization of the locally produced vegetable or animal protein foods

REFERENCES

1 Adriaens, E L (1951) *Bull agric Congo belge* 42, 227, 473

2 Brock, J F & Autret, M (1952) *FAO Nutritional Studies No 8*

3 Joint FAO/WHO Expert Committee on Nutrition, (1951) *Report of the Second Session, Rome*

4 Pieraerts, G (1942) *Rec Sci med Congo belge*, p 104

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worse than to lay down an idealistic but unattainable minimum diet For example, a few years ago in one country of the Caribbean, an agricultural policy committee received local medical advice as to a minimum diet which, when translated in terms of production and acreage, was found to require the whole of the agricultural land (including every acre under economic crops) to produce just the meat and milk portions of the proposed diet If such a programme had gone forward any hope of a nutrition campaign would have been killed Fortunately, Professor Platt, an authority on nutrition in tropical countries, was visiting the region and by tactful collaboration he was able to present a satisfactory minimum diet scale which was within the capacity of the local land resources without any restriction of production for export

At this point, I would like to refer to a question recently put to me by Professor Platt who asked whether, in my experience, it was possible to give a formula for the application of a nutrition programme In my view, a formula would have to be worked out in each country in relation to its ecological conditions and population density In fact, I can see nothing to add to the guiding principles laid down years ago by Professor Platt himself, namely a nutritional programme must preserve the balance between production for local consumption and production for export within the capacity of the national resources This can often be accurately depicted as a triangle with its base representing the national resources, and the two sides as food requirements and exports The base can be extended by means of irrigation, soil conservation, plant and animal breeding, pest and disease control, and so on Exports are, of course, necessary to pay for the imports (including foods and fertilizers non-producable locally) and services from overseas The triangle contains the population, if the two sides do not meet at an apex there is no triangle this means that the population cannot be sustained by the natural resources Serious malnutrition is then inevitable, and may even lead to starvation unless outside aid is obtainable The preparation of such triangles for countries nutritionally on or below the border-line might be a useful exercise for the United Nations agencies, as the danger-points could be depicted in a simple comparative form This, in itself, might help to draw attention to the relative needs of different countries and regions for aid in remedial measures, and to give rise to greater national effort

As, in most countries, improvement in nutrition is dependent on local production, the ministers and directors of agriculture and animal health hold the key positions in a nutrition programme Speaking as an ex-director of agriculture, I would say a pre-requisite is for a director to appreciate what a knowledge of nutrition could mean to his department The aims of the nutritionist accord with those of the agriculturist in promoting animal husbandry and mixed farming methods, they provide an added incentive to soil conservation measures and the provision of capital and communal effort for irrigation projects and water supplies, and can strengthen the case for greater appropriations for experiment stations, they can assure plantation enterprise of a well-fed labour force and they can provide

THE PRACTICAL APPLICATION OF A NUTRITION PROGRAMME

by

A J Wakefield

The question has been put to me how, in the light of my agricultural experience in East Africa and the Caribbean, do I think the foods needed to prevent protein deficiency are to be produced and made available to the people who need them

As stated in a document prepared for the Joint FAO/WHO Committee, 'it may perhaps be claimed that sufficient information is already available to enable nutrition workers to provide guidance to agriculture, animal husbandry and fisheries services' It can also be claimed that these services have sufficient knowledge and experience which, if applied and given a satisfactory response by the farming communities, could provide the foods required However, the ecological environment largely determines what can be produced, except where irrigation is possible, or a complete programme of plant breeding can be undertaken

In practice, too wide a gap too often exists between the agronomist and the nutritionist In my own case, until I met Professor Platt nutrition meant little to me, and then I soon found that it could be a great fillip to good farming, giving a firm foundation to economic development as well as a basis for social contentment

One might well ask, if so much knowledge is available, why it is that more has not been done in its application In my experience the answer lies in the philosophy that people are more important than ideas until this is accepted there can be little chance of democratic progress The problem is one of human relationships, these fall into the two spheres of (a) politicians and administrators, and (b) producers

The application of a nutrition programme is, of course, a matter for political decision Indeed, it should cover such a wide field of national endeavour as to be a matter for the Cabinet and to call for a declaration from the Head of the Government If the right approach is made, the active and valuable interests of ministers, prominent citizens and officials can be secured

Individual ministers may have to be persuaded by the nutritionist and agronomist technicians of the practicability of a nutrition programme, this goes for the leaders of 'opposition' parties, for nutrition must become a subject of national and not party politics It is not necessary to stress the humanitarian aspect, in any case, the national interest is more likely to be secured by economic facts, and a government will hardly remain unattracted by the stability and social security found in a people healthily fed

The programme put to ministers must be severely practical and related to the development of local resources Nothing could be

about milk production unless drinking water can be provided throughout the year at or near the homestead

The storage of food for man and beast is equally important A great deal of effort is made by departments to obtain relatively small increases of 5 to 10 per cent in crop yields, while 20 to 30 per cent of grain is destroyed after harvest by rodents, insects and fungi, also vast quantities of grass are annually burnt early in the dry season and there is little merit in providing people with livestock or improving the breeds unless they can be properly fed Yet the attention given to food storage has been infinitesimal in comparison to its importance Here again, little will be accomplished by too elaborate and costly a plan, large modern silos and drying plants are necessary and economic only for urban and industrial food supplies and for export, but they do not serve the rural population Farm and community silos built of local material are required to take thirty to fifty tons of grain - such as the silos of the prize winners of the Kenya Farmers' Association's competition a few years ago, and those successfully established in the Central Province of Tanganyika Small containers (half to one ton) might be made, such as wattle and daub bins raised from the ground with rodent and weather protection, covered with grass and a few inches of sand and ashes (any weevils in the grain come to the surface of the protective layer) and even smaller containers (quarter to half a ton) might be made of rice and grass straw-rope Baked clay jars might be made for seed storage The management of the communal silos must not be costly, it should be the responsibility of a village committee with a local authority employee or voluntary worker keeping the books

Although there is much information on crops, more work is needed, on (a) food crops in the tropics, particularly pulses, sorghums and vegetables (b) single plant selection from local crops (c) introductions from regions of analogous ecological conditions, and (d) plant breeding, the greatest need being for a short-period, hard-grained sorghum If plant improvement work on food or economic crops had been carried out in the tropics to the same extent as in temperate countries, the world food position would be easier

Distribution of seed and plant material of improved crop varieties must also be arranged, as is regularly done with cotton, coffee and cocoa but only at odd times with food crops The best way is to combine this with demonstration farms and plots both of local authorities and outstanding individual farmers The establishment of agricultural societies for such purposes should be considered

The problem in the semi-arid regions is usually the reduction of numbers of livestock, whereas in areas of adequate rainfall it is the provision of suitable stock A report[1] of investigations in Nigeria into the utilization of cattle for beef contains much information of value to Central Africa The production of clarified butter which is feasible both in semi-arid and high rainfall regions leads to the consumption locally of the skimmed milk The

an opportunity for improvement of peasant family life so as to ensure such a real desire on the part of rural communities for departmental services as to be inspiring to the extensions staff

A director imbued with the aims of nutrition will not rest until his minister and the government in general adopt a nutrition policy which can forward both the economic and social development of agriculture in any country Similarly, the support of social workers and employers should be sought The importance of the work of agricultural departments is then considerably enhanced

The first duty of the agricultural director is to provide the government with the facts regarding local resources and production on which a nutritional policy and programme can be decided Before this can be done, he must know the nutritional requirements which, in consultation with the nutritionist, he may have to adjust to the kind and extent of production permitted by the ecological conditions

A nutrition programme should be considered in two stages (a) that which is immediately possible and (b) the improvements which might be achieved by better methods of production, capital developments and communal effort The first can be embarked on for all practical purposes after making a rough estimate of food resources, in collaboration with sociologist and nutritionist The long-term aim requires the preparation of a comprehensive programme of agricultural development and extension work Some of the important aspects of the many which are involved in planning and development work will row be considered

The lack of **water** for domestic and farm use is the greatest limiting factor to the volume and type of food production In Tanganyika Territory, for example, five-sixths of the population are concentrated on the one-sixth of the land which contains surface water supplies Soil impoverishment of the densely populated, over-cultivated areas adjoining the great lakes has occurred to such an extent that expansion into the adjacent unoccupied unwatered land must be undertaken if low nutritional standards, even starvation, are to be avoided, this demands large-scale capital development. Much can be done, however, at little or no cost by communal effort by digging earth tanks and building dams in the semi-arid regions for ranging cattle, together with cutting and storing grass in ricks for use in the dry season, also by entombing springs and, in the more watered areas, digging irrigation furrows

The first requirements for improved water supplies are a hydrographic survey and the preparation of a population map Even a simple survey carried out by the agricultural extension staff in collaboration with the public works department is better than nothing; water supplies are so crucial, however, that in most cases the setting up of a hydrology department would be justified One of the important duties of such a department should be the trial and demonstration of means for the collection and storage of rain and surface water by communal and individual effort It is, of course, useless to talk

about milk production unless drinking water can be provided throughout the year at or near the homestead

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requirements for improvement of livestock in the semi-arid regions are the provision of water supplies, de-stocking, rotational grazing and the conservation of hay, and the control of tick-borne disease

For regions of adequate rainfall, long growing-season and dense population, Jamaica provides the most useful experience in the production of milk in the tropics Over a period of forty years a new and stable breed has been developed by a cross between Jersey and Zebu cattle, it has recently been named the 'Hope breed', and is well suited to peasant as well as large scale dairying. The great impetus to milk production in Jamaica, which now has its own condensary providing a surplus to local needs, as compared with annual pre-1939 imports of three to four million pounds, has been (a) the growing of grass as the best soil-erosion measure for steeply sloping lands and (b) the necessity of obtaining a cash income from milk The most productive system is to cut erect species of grass for stall-feeding to dairy stock. During the heat of the day high-yielding milch cows should be kept under cover which would immediately increase yields by as much as forty per cent over cows grazing in the open

The Jamaican Agricultural Society provides through its branches concentrated food and has an insurance scheme against death of dairy cows - the loss of one animal being a very serious matter to the smallholder Good peasant farmers who have suitable holdings but no capital are started in dairying with a 'revolving herd', the farmers are provided with an in-calf animal and instructed regarding the management of cow and calf Certain conditions must be observed, e.g the building of a simple shelter for stall-feeding, and adequate anti-erosion measures, including contour strips of grass If the conditions are not observed, the cow and calf are removed, if they are observed, the loan is repaid by handing over the calf at nine to twelve months The female calves are then reared for 'loans' to other peasants Stud-centres and dips are provided throughout the island and the Society collaborates with the condensary management to obtain a network of farm roads essential to the development of dairying A good veterinary service is vital to a dairy industry Jamaica, in common with other countries, is finding it difficult to obtain veterinarians

Jamaica, Trinidad and Barbados have much experience in the production of milk from milch goats yielding one to one-and-a-half gallons daily African goats are crossed with Togganburg or Alpine breeds They are stall-fed and mostly kept in towns They are the best means by which the lower-income clerical and shop assistant groups can obtain better nutrition at little cost There is no doubt that the keeping of milch goats could be introduced into Africa with satisfactory results both in nutrition and soil-conservation

Poultry have been less useful than might have been expected in the improvement of nutrition in the tropics Urban dwellers have to buy a good deal of the food required for poultry, but peasant farmers in the vicinity of towns have had good results from improved European breeds

No nutrition programme will be complete without marketing facilities, whereby produce surplus to home consumption can be sold for cash Invariably, this means the purchase and storage of grain and 'ground provisions', i e sweet potatoes and yams, by government, and certainly the development of co-operatives for such products as milk, clarified butter, eggs and poultry, tomatoes and vegetables

The active interest of the women is vital to the application of a nutrition programme yet rarely do they receive any consideration in the *formulation and operation of plans for food production* It is necessary to have well-trained sympathetic instructors in home economics and workers in social welfare, they should work in close co-operation with the agricultural extension staff

Human relationships, as stated in the opening paragraphs of this note, are deciding factors in the initiation of a programme for the improvement of nutrition Unless a director of agriculture really believes in the need for and practicability of such a programme, there is little chance of anything more than lip-service to it When a minister realizes the economic advantages and political kudos that can be forthcoming from a determined nutrition programme, then something will be done The success of what is attempted will ultimately depend, however, on the premise that people are more important than ideas The attitude of the producers, large and small, and their response to the administrative and technical measures of a nutrition campaign, will be determined by the nature of the approach made to them It should be axiomatic that no self-respecting nation willingly accepts the imposition of a foreign pattern, and people like to be consulted on measures affecting their well-being Nevertheless, in Africa the technician, working downwards through arbitrary authority, has been able to achieve spectacular results, and backward peoples have been brought to higher standards of living Few will deny, however, that in such circumstances development programmes and technical aims are vulnerable, they are even liable to collapse through such happenings as the death of a strong Chief, or the transfer of a particularly energetic technical officer or administrator The time comes when people can no longer be told just what to do, whereas if they are helped to plan and to do things for themselves, although progress may be slow at first, it is more likely to gain momentum and lead to permanent benefits

All this is now well appreciated by administering governments, and 'direct' has long given place to 'indirect' rule in many colonial countries *Even so, the preparation of plans at the* native authority level and their operation by injunction of the Chief, still retains the individual native producer in a position of some inferiority and, however much the methods enjoined upon him may afford opportunities for a better life, he is unlikely to turn to them with enthusiasm

If there is one thing which I regret in my work it is that I underestimated for too long the wisdom, inherent knowledge and

experience of those I was supposed to instruct Fortunately, in more recent years I have found that no matter how illiterate a community may be, if matters are explained and discussed in simple terms, the majority views are likely to be the right ones Certainly, if a decision for action follows consultation at the producers' level, and the proposals are likely to improve the well-being of individuals as well as the community in general, as should be the case with a nutrition programme, whole-hearted support of subsequent activities is likely to be secured

New organizations for working at what may be called the 'grass roots' level will generally have to be devised and established If these are to be effective, they must receive the sanction of, and in no way detract power from, the native authorities The prestige of the Chief would be enhanced by arranging for him to take the initiative with his people, and by making him patron of the new organization Other prominent local authorities should also be encouraged to take leading parts Often the existing tribal organizations may have to be used Indeed, this may be necessary for some years to come, as the growth of a new organization should not be hurried, it must be of an organic nature if it is to develop as something which belongs to the people and is not to appear as a foreign imposition The new organizations should provide separately for farmer, housewife and youth

The establishment of **agricultural societies** is a most important step They should be started in carefully selected villages, or throughout a district or province where conditions are favourable The ultimate aim should be a national agricultural society The chairman and committee members should all be local farmers, as suggested, it is an advantage to have patrons who are Chiefs and prominent personalities

The success of the societies will depend on the use made of them by the departments of agriculture Monthly meetings should be held to debate the farmers' problems, to determine their views of what should be done The extension agent should inject technical ideas into the discussions in such a way that the society itself takes the initiative for action Matters of especial importance should be the subject of an address or a series of talks by technicians, followed by open discussion The womenfolk should be encouraged both to attend and to speak. If some simple social function - dance or feast - can be arranged to wind up the meeting, so much the better Annual meetings linked to a show of crop products and livestock should be the ocassion for an address by a Chief, minister or permanent official The societies could also be used by other departments, particularly health and social welfare

In this way a much greater influence can be exerted on the producers than is the case where the extension staff have to contact each producer individually The producers feel they are not just being told what to do and, instead of apathy, enthusiasm for improved farming, nutrition and better standards of living can be developed

Interest in demonstration farms, seed distribution and stud centres should be developed as a means of securing co-operation of branch or village societies Members of the societies' provincial council should be appointed to advisory or even management committees of the department's experiment stations, farmers' days at the stations should be arranged through the society The producers will then begin to take an active interest in the department's work, this interest becomes an inspiration to the staff

Women should take part in agricultural and social development The need to interest them increases in proportion to their seclusion and apathy Over most of Africa the women are responsible for a great part of the work on the land, yet they are mostly ignored by the technical extension services As indications of the influence they can exert, I would cite the instance of a delegation of old women in a very backward area who, on the transfer of the agricultural officer to another district, came to bless him for his work with soil-conservation They said 'Before you came there was talk of our people having to move to another part because our lands were almost washed and blown away We have seen that your work has stopped this and our people can remain here for ever, so that our graves and the graves of our ancestors will not be abandoned We shall see to it that your work continues' In another place, a campaign for the improvement of coffee culture was rendered useless because of the opposition of the matriarch, yet no one ever thought of talking to her about its benefits A social worker in one part of the West Indies demonstrated to the womenfolk the value of milk, using skimmed and butter-milk from a neighbouring dairy farmer She was so successful that the women insisted on their husbands keeping dairy stock and got the local branch of the agricultural society to request the department of agriculture to pay special attention to their locality

However unfavourable the conditions may appear to be for starting women's institutes or some such form of group activity, a good social worker can begin the movement, especially where there are women known to be influential and dissatisfied with their present position A good start may be made by inviting the women to take part, which they readily do, in the preparations for the social activities of agricultural societies In this and other ways social welfare workers and agriculture extension agents should work as close collaborators

Whereas young farmers' clubs on the British model have not been successful in tropical countries, the 4-H Club movement of the USA has been taken up enthusiastically in such countries as Jamaica and Puerto Rico, and has been copied in India The important difference is that the 4-H Club in its pledge - hands to better service, heart to greater loyalty, head to clear thinking and health to better living for club, community and country - contains an emotional appeal and the idea of development of citizenship of great effectiveness, particularly in countries approaching self-government The movement provides for girls and boys Members select and undertake a project each year for themselves, such as the keeping of rabbits, a pig, calf

or milch goat, the growing of corn, pulses or vegetables, the decoration of a room of the house or the making of rugs for the home Simple co-operatives are founded on a club basis It is usually sufficient to impress on the club leaders and members the value of nutrition to the welfare of their community and country, and to stress the opportunity provided by their club activities for the improvement of nutrition The 4-H movement is not only a good training ground for future membership of agricultural societies and women's institutes, but, in one country at least, has led the parents to form **'pioneer clubs'**, sometimes as a branch of the agricultural society Such clubs assist old people with their gardens, the repair and buildings of their homes, and so on, they also assist in community works such as irrigation furrows and domestic water supplies

Although the idea of having **school gardens** is attractive, in practice they are often disappointing Success depends on the teacher All is well if he is a keen gardener, otherwise, school gardening may develop into an unwelcome task for the children

One of the most promising parts of the United Nations Technical Assistance programme is **economic community development** This deals with projects of great communal and national value such as the building of roads, irrigation works, dams and wells, soil conservation and the building of schools and clinics The project is selected by the people themselves and the work is done voluntarily in their spare time The important thing is that although the projects are carried out communally, each participant obtains individual benefit In one Caribbean country with a population of three millions, it was estimated that, in a year, there were twelve million idle man-days and obviously if only one-tenth of this great resource were utilized for economic community development, the people could quickly make much better living conditions for themselves at little or no cost and without extension of government services

Within three years of starting community development in Greece, several thousand kilometres of new rural roads were constructed, fifty thousand acres of land brought under irrigation and over one hundred thousand acres terraced, besides a host of projects, all of which meant more food, greater cash income and better amenities It should be comparatively easy to start economic community development in Africa where, until a decade or two ago, it was the custom for the able-bodied men of the tribe to give ten days or so free service to community projects - principally roads

Application of most of the ideas outlined depends on **local leadership** It is nonsense to say this does not exist in communities, when there has been little or no opportunity for the emergence of leadership outside the indigenous local authority structure Provide the opportunity in matters of real worth to a community and the leadership will be forthcoming Only a few carefully selected, well-trained paid organizers in social welfare, co-operatives, credit unions and the like are required to start things moving in a community Later, leaders should meet at camps to see and to discuss their work They should be regarded as the spearhead of a nutrition campaign

Plantation producers are now well aware of the benefits to their own enterprises of social welfare and other activities for their labour force, and the manner in which these contribute to goodwill It is, therefore, relatively easy to persuade the managements directly to undertake nutritional projects In Haiti, for example, fish-farming, as demonstrated by the local department of agriculture with the aid of FAO, was first started on a large sisal plantation Several ponds have been dug and 30 hectares (74 acres) of dam-water stocked with carp *(tilapia)*, the aim being, within five years or so, to provide the labour force of several thousand with a regular fish ration Livestock and poultry could also be reared and fruit trees and improved varieties of food crops grown by plantations and large farms for demonstration and sale or distribution as prizes to deserving workers

All the foregoing ideas are in successful operation in different parts of Africa or the Caribbean They aim at securing the active interest of individual producers and farming communities, and show how the work of government departments may make opportunities available for people to plan and do things for themselves For a development programme it is desirable formally to link the needs and wishes of the people to the resources of technicians and government services In recent years, many African governments have established **development planning councils** at the district, provincial and national levels Membership is usually restricted to representatives of technical departments, the administration and native authorities In such cases, all that remains to be done is to associate the work of these councils with the agricultural societies, women's institutes and youth clubs This could be achieved by appointing the chairmen of the non-governmental organizations at village, district, provincial and national levels as ex-officio members of the government development planning councils and local committees

REFERENCES

1 **Shaw, T & Colvile, G** *(1950) Report of Nigerian Livestock Mission Colon Rep No 266 H M S O*

EXPERIMENTS IN GAMBIAN VILLAGES TO ERADICATE MALNUTRITION

by

B S Platt

Two main factors have been recognized in the production of malnutrition in the Gambia - one is dietary, and the other, infection with malaria Experiments have been made in and around two villages, the first at Genieri, in which attention was mainly given to increasing agricultural production, and the second based at Keneba, in which efforts were made to reduce malaria In the demonstration, charts, photographs and various records were exhibited to illustrate the design of these experiments and some of the results achieved Brief accounts of these experiments have been published[1,2,3,4]

REFERENCES

1 Haslett, A W (1952) *Science News No 23 p 108, Penguin, Middx*

2 Haswell, M R (1953) *Colon Res Studies No 8, H M S O*

3 London School of Hygiene and Tropical Medicine *Report of the Work of the School for the year 1947-8, p 70*

4 McGregor, I A & Smith, D A (1952) *Trans R Soc trop Med Hyg*, 46 *403*

DISCUSSION

Professor HOLMES feared that a vital aspect of the elimination of the disease might have been overlooked through an undue concentration of attention on the child Was it known how far the effects of the disease lingered on in the adult, or how far he suffered as a result of subsequent periods of malnutrition? It was no good suggesting adequate corrective diets unless those upon whom food supplies depended were fit enough to work sufficiently hard to grow them Nor was it enough to feed the child adequately and ignore the possible effects of malnutrition in later periods of life

Professor PLATT said that, in spite of good feeding optimum fitness was not reached among East African troops during the war, presumably there was in them an irreversible remnant of the effects of malnutrition in childhood

Dr CLEMENTS was particularly interested in Dr Trowell's suggestion that unsubsidized milk powder should be made available for infant feeding In that connection he would like to ask Dr Trowell what was the minimum quantity of such milk that he would recommend for Uganda children of different ages to stave off kwashiorkor what would be the cost per day and what proportion of the average income of the working family that cost would represent

Dr TROWELL could not give a precise answer Dr Hebe Welbourn had stated that between ½ and 1 pint of reconstituted milk per day was enough to prevent the occurrence of kwashiorkor Skimmed milk powder cost 1/6d a pound in Uganda 2 oz of the powder gave 1 pint of fluid The cost would therefore be 2¼d a day (Imported skimmed milk powder was double the price) Wages in Kampala were of the order of 40/- a month for an unskilled labourer unaccompanied by a wife, 60/- for a domestic worker, and 100/- or more for a clerk. The relative daily cost was therefore high and for that reason Dr Dean was pressing on with the study of the possibility of working out an equivalent soya bean preparation, which would be far cheaper, perhaps half the price

Mr WAKEFIELD thought it entirely misleading to think in terms of money-income For instance in Tanganyika only 8 to 10 per cent of the total population of 7 million were wage earners, the rest grew their own food Any dietary improvement must, therefore, depend on what the people were able to grow for themselves Any surpluses grown by the peasant producer would, of course, become available for the urban communities As for the cost of skimmed milk, a United Nations survey in Kenya had shown that the average per capita income was £17 per annum, roughly a dollar a week The daily cost of a pint of reconstituted milk thus represented an impossibly large proportion of the money-income

Professor MONCRIEFF suggested that the cost of skimmed milk powder might be greatly reduced if it were used on a sufficiently wide scale

Dr AYKROYD commented on the fluctuations in the price of skimmed milk powder on the world market Three years ago it had been supplied free to UNICEF in large quantities by the United States Government which was trying to sustain the market and maintain production at a time of surplus These central fluctuations must have an effect on retail prices

Dr Trowell had mentioned Dr Dean's work on a soya bean preparation Was it known whether he planned to extend his research to preparations based on other pulses? Soya bean growing was fairly restricted and localized, but a great variety of other pulses grew in many parts of the world A study of the possibilities of using them would be a valuable contribution to the prevention of kwashiorkor

Dr PATWARDHAN commented on Dr Trowell's reference to standard dietary requirements, drawn up presumably by the National Research Council of the USA It was, Dr Patwardhan said, for national expert organizations to draw up tables appropriate to their own conditions so that the mistake should not be repeated which had been made in the past viz attempting to apply the American tables of allowances where they were not meant to be applied

Professor MAYNARD referred to the comments made on the Recommended Dietary Allowances of the Food and Nutrition Board of the USA He wished to point out that the original purpose in drawing up the figures had frequently been overlooked or disregarded, so that they had, as a consequence, been misapplied They were not 'average requirements', they were 'goals' which, when achieved would ensure adequate nutrition for almost every individual in a population, taking into account the wide range in individual needs Thus, while the average need for calcium in the adult might be little over 0 5g, balance experiments had shown that some individuals required as much as one gram Thus the latter was the figure specified in the *Recommended Dietary Allowances*

Dr Rose's figures on amino-acid requirements had often been mentioned in the course of the Conference Actually there were two sets of values (i) minimum average requirements as experimentally determined and (ii) recommended allowances which were in each case 100 per cent greater Since Dr Rose had found 100 per cent variability in the needs of individuals, he had given the higher figures in order to cover the needs of all individuals The Recommended Dietary Allowances were not intended to serve as a yardstick for measuring the nutritional status of populations Generally, lower intakes would suffice The figures were designed to meet United States conditions, and were not for world wide use The data were under constant re-examination in the light of fresh information On that basis it was expected that the present recommendation for ascorbic acid would shortly be reduced

Dr DAVIDSON NICOL urged that the FAO/WHO Monograph produced by Professor Brock and Dr Autret should be given a wider distribution in view of the importance of the subject matter He remarked that

a Northern Nigerian centre had been producing skimmed milk for some six months, the cost was less than for imported milk He wished to know whether groundnuts, of which there was a surplus in Northern Nigeria, could be used in the way suggested for soya bean, and, also, in what form Dr Raoult proposed that meat should be given to infants

Dr AUTRET said that groundnuts had a low coefficient of digestibility and unless carefully prepared could give rise to gastro-enteritis At a welfare centre in Ruanda-Urundi a preparation of groundnuts and cassava flour had been used, but although it caused no gastro-enteritis it did not lead to any improvement in weight The experiment had been abandoned, moreover, because mothers could not be persuaded to go to the trouble necessary to prepare the food

With regard to the wider distribution of literature, he said that all the money available for FAO and WHO publications was being used, and that there was a limit to the number of documents which could be distributed free The question of a wider dissemination of knowledge would however be placed on the agenda of the Joint Committee of Experts of FAO and WHO

Professor MONCRIEFF, in answer to Dr Davidson Nicol's question about groundnuts, said that the coarse forms of carbohydrate should be avoided since they required elaborate preparation if they were not to bring on irritative diarrhoeas

Dr EDINGTON thought too much emphasis had been placed on a single food, skimmed milk, as the sole means of correcting the dietary deficiency which gave rise to kwashiorkor It would be far more realistic to find a means of assisting each territory to solve its own feeding problem within its own resources

Dr AYKROYD felt that it was opportune for him as an initiator of skimmed milk feeding to warn the Conference that the main producing countries (the United States, Canada, Holland, New Zealand and Australia) could never supply enough to satisfy the needs of all the children throughout the world to whom it would be beneficial He therefore supported Dr Edington's view that the basic problem of improving nutrition should be tackled on a strictly local basis

Professor DAVIES was concerned at the high death rate in the early years of adult life in Uganda In more than 3,000 autopsies at Mulago Hospital the average age of death, even after excluding all deaths in children under the age of 10 years, was just under 30 years Only a small percentage of deaths took place over the age of 40 years His figures had been criticized as too selective, but now the census figures were coming out and it was clear that the Mulago figures represented with fair accuracy what was happening He felt sure that many of these deaths in early adult life were a consequence of malnutrition and this low expectation of life - even after childhood - must influence the community most adversely

Lt-Col LAURIE after a brief reference to the effective collaboration between biochemists and doctors in recent years, said he was of the opinion that the only satisfactory method of treating kwashiorkor was by prevention, e g increased production of locally available vegetable and animal proteins In that connection Mr Wakefield's observations were pertinent In the framing of its resolutions, the Conference would do well to draw the attention of member governments to the need for immediate and long-term planning in the utilization of African foodstuffs

Professor GYORGY urged that, in the framing of the recommendations, a clear distinction should be drawn between the preventive and the therapeutic measures, the latter being applicable to a sick organism, whereas preventive measures were designed for the maintenance of a normal body

Mr WAKEFIELD referring to his communication to the Conference, (page 332) stressed the importance in any food production programme of utilizing the resources which were to hand, particularly the vast quantities of crude protein present in grass, this was usually lost by burning, but could become a valuable food for milk production if the grass was cut young, fed directly or dried for use in the dry season He also referred to the vast numbers of cattle and goats throughout central Africa which made little contribution to local food supplies, however, in some areas considerable headway was being made despite traditions and customs adverse to milk production

Mr Wakefield pointed out the advantages of stall feeding, and referred to the use in the West Indies of African goats crossed with such milk breeds as the Togganborg and Alpine for the home production of milk in urban areas He drew attention to the role played by grass in the control of soil erosion and the rehabilitation of land, it could prevent land becoming unsuitable for the production of cereals and pulses He stressed again that the grass planted as an anti-erosion measure could be turned into milk by stall fed cows and goats

In regard to extension methods, he felt that a change of attitude on the part of technicians and extension agents was generally desirable, and he held the view that there should be more consultation with the farmers as to their needs and plans for amelioration In this connection he considered it to be imperative to start at the individual family level within the village He also held that there was a great need for more channels of communication, and instanced agricultural societies, women's groups, and youth clubs, suggesting that the prestige of chiefs and village notables would be enhanced if they became patrons of such movements which, he thought, could do much to counter the dullness of rural life and provide outlets for leadership

Dr AYKROYD drew attention to the note prepared by the Fisheries Division of FAO, for discussion at the forthcoming meeting of the Joint FAO/WHO Nutrition Committee, about the possibility of

increasing the supply of fish as a means of supplementing protein deficient diets Special emphasis had been laid on the development of fish ponds

Dr EDINGTON strongly advocated the establishment of a mixed nutritional team for the purpose of advising the respective Governments on the prevalence of malnutrition and the measures to be taken to combat it

It would be for such a team to examine the problem on the spot, to study environmental conditions, and existing facilities and possible methods for the improvement of crops in quality and character

Dr HAWE submitted that kwashiorkor should be regarded more as a widespread social disease, actually manifested in certain age groups and possibly only of recent origin in Africa There was little evidence to prove that infection played any part in its development He stressed that care should be taken in the drafting of recommendations, since a social disease could not be defined and eradicated by therapeutic measures alone

In his view, close attention should be paid to addition of food of suitable quality for both the mother and child during a prolonged weaning period until the child was able to digest ordinary food

Professor RAOULT stressed the essential need for the education of the people in the importance of making the best use of foods available to them What was needed was guidance and proper advice rather than the provision of supplementary foodstuffs Nor was kwashiorkor necessarily an indication of extreme poverty - he had seen instances in Dakar of bejewelled women whose children were suffering from the disease, and who could well afford to pay for an improved diet

THE SESSIONAL CHAIRMAN (Professor Brock) summed up He recalled that the subject of the Conference was the nutrition of the mother and child in Africa and that the title of the session was treatment and prevention Those two terms were obviously intended to refer particularly to what was believed to be a widespread form of African malnutrition resulting from deficiency, in either quantity or quality or both, of protein intake particularly when it was associated with a free intake of starchy foods All were agreed that the resulting nutritional disorder in the weaned child was that which had been referred to as kwashiorkor

The first half of the discussion had been focused upon the treatment of severe kwashiorkor and the prevention of its milder precursors by giving suitable diets to the wholly or partly weaned child In the second half, attention had shifted to the role of maternal protein malnutrition in the production firstly of a child malnourished or immature at birth and secondly of inadequate lactation It was likely that the shift of focus to maternal protein malnutrition might be of the greatest importance Even though the

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Another paper had directed attention to strategy in public health policy His chief comment on the discussion of therapy was that no reference had been made to the psychology of the kwashiorkor child Some people present at the Conference might think the patience, tact and skill of the nurse who administered the milk protein more important than the vitamin and endocrine supplements which were advocated The same argument might be applied to the actions of public health administrators He recalled the old adage 'You can bring a horse to the water but you cannot make it drink' Neglect of that aspect of health policy might result in the failure of the best-conceived policies

contribution of the maternal breast to the protein and calorie needs of the child might be relatively small in the second year of life, it might nevertheless be fundamental through as yet unidentified accessory food factors in human milk.

It should also be remembered that although the Conference had provided an excellent stimulus to scientific research and discussion, its fundamental purpose was to enable member governments to understand just how important protein malnutrition might be as a health problem in the African continent, and what they could do for both its prevention and correction It had rightly been emphasized that the solution must be worked out for each territory within the peculiar pattern of its food potential and its own assessment of the extent or severity of malnutrition within its borders Perhaps the greatest lack was precise knowledge of the frequency of kwashiorkor Although exact figures were not yet available, few delegates and observers at the conference would doubt, after the discussions and the case demonstrations, that protein deficiency was widespread and that for every case of typical kwashiorkor that was recognized there were probably hundreds of cases in which health and efficiency were marred by protein deficiency during the formative period of life It would probably be agreed by many that it was likely that the damage done in the post-weaning period of life was carried forward into adult life and there determined, at least in part, the underdeveloped state of the African continent

If these views were correct, member governments would want some concrete suggestions about treatment and prevention The discussion on skimmed milk had not brought out the point clearly enough that although dried skimmed milk was probably the most efficient and the cheapest way of treating kwashiorkor, it was clearly not going to make any major contribution to the prevention of kwashiorkor or other forms of protein malnutrition in Africa One paper had shown that skimmed milk might be used as a 'starter' in a scheme of mass prophylaxis but only to bridge the period required for the intensification of local production of protein-rich foods, and the education of communities in their use The paper on soya bean as a curative, and therefore, presumably, as a prophylactic weapon was fundamental because it was generally conceded that the production of sufficient animal protein for the apparent needs of African communities was unlikely in the near future Attention had been drawn to the apparent prophylactic value of locally produced beans in the Ruanda-Urundi, and to the fact that effective vegetable milk substitutes prepared from indigenous beans and nuts are known to primitive peoples Chromatography might soon yield valuable information on the comparative value of vegetable proteins The need for using the maternal metabolism as a machine for the provision of digestible and assimilable protein foods for the infant had been the subject of the second part of the discussion The correction and prevention of protein malnutrition in mothers, and improvement in the quality and duration of maternal lactation, might be the most important steps that could be taken in the eradication of kwashiorkor from Africa

A NOTE ON DEFINITIONS AND TERMINOLOGY OF A MALNUTRITIONAL DISORDER IN CHILDHOOD

by

H. C. Trowell

Definition of severe kwashiorkor

In making the diagnosis of severe kwashiorkor attention should be paid to the history of the disorder, the preceding diet, the age of the patient, the results of the clinical examination, a consideration of the biochemical and pathological changes, and the response to treatment The relevant signs and considerations are

(a) The child is always seriously ill and there is a high mortality in untreated cases
(b) Most cases occur from the ninth to the thirty-sixth month, the most severe ones developing after complete cessation of breast feeding. The disease does not occur during the first few months of life if breast feeding has been adequate in amount It is rare during childhood after four years of age
(c) The weight is always markedly subnormal, especially when allowance is made for the presence of oedema
(d) Oedema is usually present, it may be variable in amount and it may be lost during dehydration A few cases, typical in all other respects, display no clinically demonstrable oedema, although they are seriously ill
(e) The muscles are always wasted
(f) The hair always shows some change in its texture and there is usually some loss of pigment, if this has previously been dark in colour Those having a dark skin often show some loss of pigmentation, especially around the mouth
(g) Mental apathy is always present and many cases often display peevishness when they are disturbed
(h) The pancreatic enzymes are always seriously reduced, this is manifested by the passage of undigested food in the stools, and confirmed by atrophy of the zymogen granules of the acinar cells seen in autopsy material obtained from untreated cases The stools are usually, but not always, loose they tend to be bulky in comparison with the amount of food eaten
(i) Moderate anaemia almost always occurs, it is usually normocytic but may be macrocytic as regards mean corpuscular volume
(j) The serum albumin is always seriously reduced.
(k) At a certain stage in the illness fat accumulates in the periphery of the hepatic lobules, and the whole organ may enlarge, but the enlargement is an inconstant sign

Terminology

Kwashiorkor is a term which has the following merits

(a) The term arose among the common people who recognized the disease among weanlings, and it is fitting that a term employed by one of the tribes in Africa in which there is so much of the disease should be employed The names of other common dietary diseases have usually come from the language of the laity (scurvy, *rickets*, *pellagra*, *beriberi*) and have seldom been replaced by the more scientific terms which define the deficiency

(b) Historically speaking the first adequate description in recent times[7,8,9] set forth this term, and although there were earlier descriptions of the disease they were usually poor or a name was given which could not be applied outside the area concerned (*Bouffissure d'Annam*[5], *Oedema disease of Haiti*[6])

(c) Etymologically the term kwashiorkor is suitable and it does not define prematurely the cause of the condition or draw attention to any single feature of the disorder It is certain that this term contains no reference to any redness of the hair, a mistranslation on this point has offended many There are many causes besides malnutrition which produce dyspigmentation of the hair

(d) The term probably describes in the Ga language of the Gold Coast *an illness contracted by an infant whose mother* became prematurely pregnant, the older child therefore tended to be weaned prematurely and was deposed[8] There were many shrewd insights therefore into premature weaning, the protection afforded by breast milk, and a hint of the relationship to over-population

(e) *In her original description in 1931-2, Williams*[7] *clearly* demonstrated in charts of children's weights the fact that a mild condition of arrested growth might deteriorate and become severe It is questionable if the term kwashiorkor should be restricted to advanced cases

(f) No other term has commended itself widely in Africa, Asia, the United Kingdom and the United States

Objections to the term kwashiorkor are

(a) The term is offensive to European and South American people who have, however, accepted without offence terms such as beriberi and sprue

(b) Its introduction implies disregard of the literature on *mehlnahrschaden* which however became obscured with marasmus and atrophy and never contained clear descriptions of the changes in the hair or in the pancreas, nor stressed the distribution of the fat in the periphery of the liver lobule The term mehlnahrschaden is incorrect in implying that starch damaged the infant

(l) The appetite is variable at the beginning of the illness, it is markedly impaired in advanced cases
(m) The preceding diet when assessed has always been found to contain a low proportion of protein to calories, breast milk or cow's milk, if taken, has been small in amount
(n) Some cases may exhibit, partly depending on the staple composition of the diets, certain terminal and variable features which appear to be due to associated vitamin deficiencies, especially all those of the B-complex and of vitamin A
(o) This severe condition is usually ameliorated in all its apparent respects on treatment with a protein rich diet

The definition given should not be taken to exclude other aspects of the disorder which have already been reported but which are awaiting confirmation

Certain clinical workers have observed that cases vary from one district to another, but it seems unwise to recognize sub-varieties of the same basic condition until a firm distinction can be made in terms of the preceding dietary history, the clinical signs, the biochemistry and the pathology of the alleged variants, and of the response to treatment

Definition of mild kwashiorkor

It is impossible at the present time to define precisely the milder disorder for there is little precise knowledge concerning the normal growth of different ethnic groups. Even within these groups considerable individual variation of growth certainly occurs

At the present time it is unwise to diagnose the milder variety of this disorder in any country in which there appear to be no severe cases If the presence of severe cases is firmly established, then a milder state of the same disease may be presumed to be present in cases which cannot be explained by an infection, underfeeding, or other recognized disorder and to have the following features

(a) The child is not seriously ill
(b) The age is early childhood
(c) The weight, and more particularly the height, are definitely subnormal
(d) The child seldom shows oedema but other changes in the clinical state and in the biochemistry and pathology characteristic of the severe disease may begin to appear
(e) The hair shows some change in texture and if previously dark usually displays some loss of pigment
(f) The dietary history reveals a low intake of protein
(g) All signs of the mild disorder respond when a protein rich diet is administered

The mild disorder should never be diagnosed upon finding one sign, such as that of the dyspigmented hair, but only upon a consideration of all aspects of the case, including the response to treatment

DISCUSSION

Professor FRONTALI said that for about 40 years the name 'mehlnahrschaden' had been commonly used in Europe, particularly in Germany, Greece and Italy, but that the term 'starchy food dystrophy' had been adopted in Italy from 1925 onwards, precisely in order to avoid the pathogenetic implication of damage due to amylaceous food The term did not imply wasting; etymologically, 'dystrophy' meant 'bad nutrition', so that the English term 'malnutrition' was a fairly close equivalent But the word 'dystrophy' alone was, as Dr Trowell had pointed out, an inadequate description of the particular disease under consideration The words 'starchy food' had been prefixed to 'dystrophy' because starchy food formed the main element of the faulty diet which, when given to the child at weaning time, brought on the disease The use of the words 'starchy food' also had a propaganda value in discouraging the feeding of children with paps exclusively

Since Czerny had given the disease a name, much study had been given in Europe and Africa to the clinical, laboratory, pathological and pathogenetic aspects (including those of the pancreatic enzymes and the fatty infiltration of the liver) and knowledge of the disease had increased considerably That was, however, no reason for changing its name which was familiar to paediatricians, general practitioners and the lay public all over Europe, Only the untutored would confuse starchy food dystrophy with marasmus or atrophy

'Kwashiorkor', which was itself far from being common to all those parts of Africa where the disease had been observed seemed to imply that a new, tropical disease had been discovered but that was not the case The local names 'beriberi' and 'sprue' had been acceptable because they had really been described for the first time in the tropics in Indonesia and the Far East The fact that dyspigmentation was more marked among Africans was no good reason for ignoring all the earlier work on the subject carried out in Europe

There was nothing against using the term 'kwashiorkor' for the complex syndrome (or 'spectrum', as Professor Brock had called it) with its malarial complications, helminthic infestations, the sequential cirrhosis in children and adults, and so on But observations made in Europe with regard to the more clearly delimited 'starchy food dystrophy' might be useful to research workers in Africa who could perhaps separate it from the broader, more complex syndrome known to them as 'kwashiorkor'

He would urge, therefore, that the term 'starchy food dystrophy' be retained, *and not be replaced by the word 'kwashiorkor'*

Professor MONCRIEFF was troubled by the ambiguous use of the word 'weaning' in Dr Trowell's note Professor PLATT agreed that the straightforward terms 'breast feeding' and 'taking off the breast' – which suggested the great break that the event was felt to be – were more acceptable Dr WATERLOW believed that although

It is considered that the term *starchy food dystrophy* [3,4] suggesting the fact that an excess of starchy food causes dystrophy, recognizes the debt to the literature on mehlnahrschaden and will become widely employed in Southern and Central Europe and Central and Latin America It is unlikely to become acceptable in the United States, the United Kingdom, Northern European countries, Asia, or Africa

There are certain objections to the use of the term dystrophy which, in the British and American nomenclature, suggests wasting, whereas in kwashiorkor children often appear chubby or even blown up with oedema and may have some subcutaneous fat

The terms *nutritional dystrophy* [1] and *alimentary dystrophy* [2] are also considered unsuitable, likewise any term which suggests that multiple deficiencies of vitamins occur

REFERENCES

1 Achar, S. T. (1950) *Brit med J*, I, 701

2 Choremis, G (1950) *In Sixth International Congress of Pediatrics, Summaries of Communications*, p 130, Zurich

3 Frontali, G. (1927) *Lectures on Child Nutrition*, Rome

4 Frontali, G. (1949) *Pediatria Internazionale*, No 1

5 Normet, L. (1926) *Bull Soc Pat exot*, 19, 207

6 Payne, G. C. & Payne, F. K. (1927) *Amer J Hyg*, 7, 73

7 Williams, C. D. (1931-2) *Annual Report of Medical Department, Gold Coast*, Government Printer, Accra

8 Williams, C. D. (1933) *Arch Dis Childh*, 8, 423

9 Williams, C. D. (1935) *Lancet*, II, 1151

NOMENCLATURE OF KWASHIORKOR

by

J. C. Waterlow

The name of a disease must (a) indicate the cause or nature of a disease process, or (b) indicate a lesion regardless of cause, e g. pneumonia, or (c) act as a code-word to describe a definite group of symptoms and signs Confusion often results when an attempt is made to combine these different types of name, e.g. the attempt to equate pellagra and nicotinamide deficiency Most of us would agree that at present the name 'kwashiorkor' belongs to category (c). To elevate it to category (a) and equate it to protein deficiency would be premature

If the name 'kwashiorkor' is descriptive, the object of any definition must be to bring together under one head as wide a range of cases as possible that have certain features in common, in order to emphasize the fundamental unity of this group of cases and their difference from other types of case Admittedly, there is a wide measure of agreement on the essential features which differentiate the kwashiorkor syndrome from other types of malnutrition But, from the practical point of view, many of the fundamental features which most of us are agreed upon cannot easily be diagnosed clinically, e g. pancreatic atrophy and response to treatment, if hospital facilities are not available

In spite of the benefit of all the discussions during the Conference, I could not give a straightforward answer to the question whether the cases we have seen here are or are not kwashiorkor Moreover, if I were asked this question about the cases that I study in detail in Jamaica, of some I would say 'yes', of others 'no', but of the majority, 'I am not sure' I think that many doctors in the field would have a similar difficulty, however careful a definition is given

We visualize an attempt to get information on a world wide scale about the incidence of kwashiorkor If this word were used, an extra element of uncertainty would be added to the results of the inquiry because of doubt about the interpretation made by the doctor on the spot We would have to try to give an extremely rigorous definition of the syndrome to minimize this element of doubt I submit that such an attempt would be a waste of time, since what really concerns us is not the use of words but the nature of the disease process

I cannot see any disadvantage in making inquiry about the incidence of malnutrition in infants with special reference to certain symptoms and signs It would be important for us to list these We should be able to do so without undue controversy for example, whether or not one thinks that red hair is essential to the syndrome, nobody can have any objection to its incidence being noted

in principle it was well to define a disease and to identify its cause, in the present instance it was premature to attempt to do so, and might prejudice further work on the subject. Moreover, 'kwashiorkor' in the present state of knowledge was difficult to diagnose.

Dr. TROWELL accepted certain of Dr Waterlow's criticisms but defended his reference to the 'response' of the condition to protein treatment In reply to Professor Gydrgy, he said that he made no exclusive claim for the curative effect of a protein-rich diet, for breast milk was highly protective He considered that if a correct diet were administered continuously, fibrosis of the liver might not occur Professor PLATT objected that if the condition was due merely to protein deficiency, the symptoms would be identical in the Gambia and in Uganda, but in fact they were different Professor MONCRIEFF and Professor DAVIES supported his view that stress should be laid on the level of protein intake relative to that of carbohydrates The danger lay in an unbalanced diet The overt forms of the disease, then, were the varying results of injury in the presence of protein deficiency

Dr TROWELL considered that the difference in the protein calorie ratio in the Gambia and in Uganda would probably account for the differences seen in manifestations of the disease Appetite was often a good indicator of the earliest manifestation of the disease but as the organs became impaired the intake would fall below actual requirements.

NAMES FOR PROTEIN MALNUTRITION* IN CHILDREN

Compiled by

M. Autret

The names given below have been applied by different authors to syndromes which have the same basic characteristics as kwashiorkor In some instances the descriptions of the syndrome observed are incomplete, nevertheless it can be inferred that the syndrome belongs to the same general type or category In Europe, the expression 'dystrophie des farineux' is retained, there is a preference in parts of Africa for the term 'kwashiorkor', in India for 'nutritional dystrophy', and in Latin America the term 'sindrome policarencial en la enfancia' is commonly used

Name	*Place*	*Approximate date of first use*
Kwashiorkor[35]	Gold Coast	1933
†Infantile pellagra[29]	Tropical Africa	1937
Malignant malnutrition[30]	South Africa and Uganda	1944
Sugar baby[25]	British West Indies	1947
Fatty liver disease[34]	Jamaica	1948
Nutritional oedema[18]	Europe	1920
Endemic nutritional oedema[36]	U S. A.	1933
Hypoproteinosis[20]	Mexico	1948
Bouffissure d'Annam[21]	French Indochina	1926
Dystrophie des farineux[10]	France	1910-20
Enfants rouges[16]	French Cameroons	1932
Degenerescence graisseuse du foie[3]	French West Africa	1948
Syndrome de denutrition maligne[2]	French West Africa	1948
Maladie oedemateuse du sevrage[9]	Morocco	1949
M'Buaki[31]	Belgian Congo	1938
Syndrome depigmentation-oedeme[24]	Belgian Congo	1942

* The use of the term 'protein malnutrition' was not discussed at the Conference It seems, however, as if it might become a generally acceptable term. - *Ed*

† see also Gillman, J & Gillman, T (1951) Perspectives in Human Malnutrition, Grune & Stratton, New York.

INFANTILE CIRRHOSIS OF THE LIVER

by

M. V. Radakrishna Rao

A clinical entity, perhaps associated with protein deficiency, has been described in India under different names such as infantile biliary cirrhosis, infantile cirrhosis of the liver, and infantile liver. It is a progressive and rapidly fatal disease commonly seen in the children of the middle and rich class vegetarian Hindus, between the ages of one and three years

The first symptom noticed by the parents is usually the inactivity of the child, who becomes dull and morose The appetite is generally lost and constipation is very marked, there is rarely diarrhoea. A low irregular fever is often evident at this stage, when the skin loses its glossy appearance and becomes muddy The liver is slightly enlarged, slightly resistant on palpation, and painless Examination of the blood does not reveal any abnormality at this stage, except a slight leucocytosis

As the disease progresses, irritability and peevishness are more marked and there is an irregular and intermittent or, rarely, low remittent fever Constipation is marked and the stools are dirty white in colour The conjunctiva shows a subicteric tint The liver is enlarged, the lower border generally reaching to the level of the umbilicus and sometimes beyond it

The clinical picture in the terminal stages is one of deep jaundice and cirrhosis with gradually supervening evidences of portal obstruction resulting from a terminal contraction of the liver

It is rare to see children surviving more than six to ten months after the onset of the first symptoms and the enlargement of the liver An early termination is usual after the onset of ascites

Histologically, the liver shows a subacute necrosis of the parenchyma, extensive obliterative lesions of the smaller divisions of the hepatic venous tree and replacement fibrosis, attempts at regeneration of the hepatic parenchyma are usually not marked

Although the malaise, loss of weight and the enlargement of the liver in the early stages of infantile cirrhosis are similar to those seen in kwashiorkor, there is rarely evidence of oedema, except in the terminal stages of the disease

REFERENCES

1 Rao, M. V R (1924) Antiseptic 21, 723

2 Rao, M. V R. (1934) Indian J Pediat , I, 159, 166

3 Rao, M. V. R. (1935) Indian J med Res , 23, 69

4 Tirumurti, T S. (1934) Indian J Pediat , I, 153

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The names given below have been applied by different authors to syndromes which have the same basic characteristics as Kwashiorkor In some instances the descriptions of the syndrome observed are incomplete, nevertheless it can be inferred that the syndrome belongs to the same general type or category In Europe, the expression 'dystrophie des farineux' is retained, there is a preference in parts of Africa for the term 'kwashiorkor', in India for 'nutritional dystrophy', and in Latin America the term 'sindrome policarencial en la enfancia' is commonly used.

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† see also Gillman, J & Gillman, T (1951) Perspectives in Human Malnutrition, Grune & Stratton, New York.

Diboba[24]	Belgian Congo	1942
Imbeho[33]	Urundi	1952
Irungu[33]	Ruanda	1952
Distrofia da farine[10]	Italy	1927
Mehlnahrschaden[8]	Germany	1906
Nutritional oedema[6]	China	1942
Malnutrition in infants[14]	Egypt	1947
Nutritional dystrophy[1]	India	1949
Nutritional oedema syndrome[2]	India	1950
Culebrilla[22]	Yucatan (Mexico)	1937
Síndrome pelagroide beriberico[27]	Cuba	1935
Edema y avitaminosis de la infancia[23]	Costa Rica	1937
Caquexias hidrícas tropicales infantiles[11]	El Salvador	1937
Avitaminosis compleja infantil[32]	El Salvador	1938
Edemas de la infancia[7]	Guatemala	1938
Mala nutricion[15]	Spain	1942
Síndrome hipoproteinico avitaminosico[28]	Mexico	1942
Distrofia farinacea[13]	Uruguay	1942
Sindromes policarenciales en la infancia[27]	Chile	1941
Desnutricion por carencia proteica[26]	Mexico	1946
Distrofia pluricarencial hydropigenica[4]	Brazil	1945
Desnutricíon en el lactante mayor (distrofia policarencial)[19]	Chile	1949

REFERENCES

1 Achar, S. T. *(1950) Brit med J* i, 701

2 Bergeret, C. *(1948) Bull med A.O F*, 2, 257

3 Bergeret, C. *(1950) La degenerescence graisseuse du foie de l'enfant noir ses rapports avec la cirrhose et le cancer du foie In Conference Interafricaine sur l'Alimentation et la Nutrition Dschang, Cameroun 1949, p 382*

4 Carvalho Magalbaes, J., Pinto, G. A. et al (1945) *J Pediat, Rio de J*, I, 395

5 Castellanos, A. (1935) *Rev cubana Pediat*, 7, 5

6 Chen, J. (1942) *Amer J Dis Child*, 63, 552

7 Confino, V. E. (1938) *V Congreso medico Centro America y Panama*, p 543

8 Czerny, A. & Keller, A. (1906) *Des Kindes Ernahrung, Ernahrungsstorungen and Ernahrungsterapie*, Leipzig, 1926

9 Delon, J. (1950) *Maroc med*, No 299, p 333

10 Frontali, G. (1927) *L'alimentazione del bambino, Lezioni* _ ediz Ed Pozzi, Rome

11 Goens Rosales, A. (1934) *Caquexias Hidrícas tropicales infantiles II Congreso medico Centroamericano, Costa Rica*

12 Gopalan, C & Patwardhan, V. N. (1951) *Indian J med Sci*, 5, 312.

13 Guerra, R., Gianelli, G. & Peluffo, E. (1942) *Arch Pediat Urug*, 13, 402

14 Hanafy, M. (1947) *J Egypt med Ass*, 30, 440

15 Jimenez Diaz, C., Lorento, L. et al. (1942) *Rev clin esp*, 7, 184

16 Lieurade, M. (1932) *Bull Soc Pat exot*, 25, 46

17 Marfan, A. B. (1923) *Les affections des voies digestives dans la premiere enfance*, Masson, Paris

18 Maver, M. B. (1920) *J Amer med Ass*, 74, 934

19 Meneghello, J. R. (1949) *Desnutricion en el lactante mayor (distrofia policarencial)*, Central de publicaciones Santiago de Chile

20 Miranda, F. de P. (1948) *J Amer med Ass*, 136, 542

21 Norret, L. (1926) *Bull Soc Pat exot* 19, 20-

22 Patron Correa, J. (1908) *Rev med Yucatan* 3, 89

23 Pena Chavarria, A. & Rotter, W. H. (1937) *Rev med C Rica*, No 36, 5 536

24 Pieraerts, G. (1942) *Rec Sci med Congo belge* p 104

25 Platt, B S (1947) *Trans R Soc trop Med Hyg*, 40, 379

Diboba[24]	Belgian Congo	1942
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REFERENCES

1 Achar, S. T. *(1950) Brit med J*, 1, 701

2. Bergeret, C. *(1948) Bull med A O F*, 2, 257

3 Bergeret, C. *(1950) La degénerescence graisseuse du foie de l'enfant noir ses rapports avec la cirrhose et le cancer du foie In Conference Interafricaine sur l'Alimentation et la Nutrition, Dschang, Cameroun, 1949, p 382*

1 The Conference

agrees that from the evidence of clinicians, pathologists and biochemists there are in many areas of Africa ill health and disease due to malnutrition These occur in people on diets deficient in quality and quantity of protein and are sometimes aggravated by inappropriate preparation of food and by digestive disturbances Some manifestations of the effects of protein deficiency arise, or are more pronounced when the low protein in the diet is associated with a relatively high proportion of carbohydrate Other factors, such as the insufficiency of other essential nutrients in the diet, infestations and infections, may also modify the clinical picture, but are not constant features

agrees that the most severe forms of these disorders usually appear in infants and young children, although the foundation in some children may be laid in the pre-natal period of life

accepts that a common and precisely defined form of malnutrition is known and has been given various names, but is recognized mostly under the name of kwashiorkor both in Africa and in other parts of the world

agrees that unless properly treated many infants and children suffering from the more severe forms of malnutrition die, and that successful treatment is now possible in all but the most severe cases

recognizes that for some time to come in spite of the preventative measures that might be undertaken, these conditions will continue to arise

recommends that the information necessary to make possible the ready identification by dispensary, social welfare and other workers of all forms of malnutrition, more particularly in their advanced forms, should be disseminated as widely as possible and that the necessary materials for early treatment should be made readily available

2 The Conference

recognizes that in its deliberations it has on occasions found itself under the severe handicap of lack of knowledge of many important matters

emphasizes that much further information should be gained and recommends that Governments should support, and wherever possible extend, research into nutrition in the widest aspect of this subject and draws attention in this connection to the inadequacy of basic knowledge of the biology of the African and the need for more extensive investigations into this, and into the exact incidence of nutritional disorders and into the biochemical and pathological lesions which are seen in these disorders

26 Prado Vertiz, A. *(1946) Rev mex Pediat*, 15, 275

27 Scroggie, A. *(1941) Rev chil Pediat* 4, 247

28 Torroella, M. *(1942) Rev mex Pediat*, 12, 114

29 Trowell, H. C. *(1937) Arch Dis Childh*, 12, 193

30 Trowell, H. C. *(1944) Clin Proc*, *Cape Town*, 3, 381

31 van Daele, G. *(1938) Ann Soc belge Med trop*, 18, 653

32 Vidal, A. *(1938) Avitaminosis complaja infantil en Honduras, V Congreso medico Centro America y Panama*

33 Vincent, M *(1952) Personal communication*

34 Waterlow, J. C. *(1948) Spec Rep Ser med Res Coun*, *Lond*, *No 263*

35 Williams, C. D. *(1933) Arch Dis Childh*, 8, 423

30 Youmans, J. V. & Bell, A. *(1933) Arch intern Med*, 51, 45

7 The Conference

recording its satisfaction at the presence during its proceedings of the members of the Joint FAO/WHO Expert Committee on Nutrition, and its appreciation of the valuable technical services placed by the Committee at the disposal of the Conference,

voices its thanks for the invitation extended to its members to attend as observers at the meeting of the Joint Expert Committee and its hopes that the findings of the Conference will be further discussed and elucidated at the meeting of the Joint Expert Committee,

recommends that a further Conference should be held within the next three years to study practical means of improving indigenous food supplies along the lines recommended*, and hopes that the valuable co-operation between the members of the CCTA and the FAO, WHO and other international organizations will continue in connection with future Conferences

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* *Subsequent conclusion of CCTA Working Party* 'The Joint Working Party took note of the recommendations presented by the CCTA Nutrition Conference which took place at Fajara in November 1952 and recommended that the Member Governments should be invited to appoint correspondents in the field of Nutrition These correspondents would enter into direct consultation with each other and with CSA [Scientific Council for Africa South of the Sahara] and possibly meet as an interterritorial committee of experts on nutrition problems It is expected that the inter-African technical Bureaux concerned with various aspects of the nutrition problem would be brought through CSA into this circuit of mutual consultation '

Some nutrition correspondents have already (January 1954) been appointed

Belgium for Belgium - Le Medecin attache a l'Inspecteur General de l'Hygiene,
Ministere des Colonies,
Bruxelles

for the African territories - Le Medecin-Inspecteur du Service de l'Hygiene,
7e Direction Generale
Gouvernement General du Congo Belge
Leopoldville

France (provisionally) - Le Directeur du Service de Sante
Ministère de la France d'Outre-Mer
27 Rue Oudinot
Paris 7e

Southern Rhodesia - Dr E Baker Jones
P O Box 93
Causeway
Salisbury

United Kingdom - Professor B S Platt C M G ,
Applied Nutrition Unit
London School of Hygiene & Tropical Medicine,
Keppel Street
London W C 1

emphasizes the need for the follow-up of treated patients in order to determine the degree of reversibility of the lesions, and to continue to study the effects of malnutrition on persons protected from the effects of infestations

3. **The Conference**

agrees that in the prevention of malnutrition the aim should be to achieve as much as possible by the proper utilization of existing and potential resources of protein, vegetable and animal, in the areas where malnutrition occurs

considers that the proper utilization of existing resources requires the co-operation of all government services and of voluntary organizations and believes that restorative measures should start at the family level within the village or small community

recommends that Governments should take such measures as they deem appropriate to bring to bear the knowledge and experience of the several technical, social and administrative departments in their territories on the problem raised by these questions, with a view to the improvement of food production suitable to their territories more especially in regard to protein, vegetable and animal and to the extension of knowledge of the effects of badly balanced and insufficient diets on mothers and children It is nevertheless recognized that improvement in the nutrition of the family cannot be effectively begun, or lasting improvement achieved, until the nutrition of adults, especially women, is improved to a point which will permit substantial increases in the effort that can be devoted to food production

4 **The Conference**

recognizing the work that is already being done in the field of nutrition and the closely related fields of agricultural and community development,

recommends that suitable measures should be considered for the regular interchange of information which will contribute to the improvement of nutrition This interchange should take place both within territories and between territories in Africa, and with the interested scientific organizations and appropriate specialized agencies of the United Nations

5 **The Conference**

recommends that its proceedings, together with communications, should be published in English and in French and made available for the information of workers in this field

6 **The Conference**

expresses its warm sense of gratitude and indebtedness to the pioneer workers in the field of nutrition in Africa

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Italicized numbers indicate whole communications or demonstrations

CONCLUDING REMARKS

Dr HAWE speaking on behalf of delegates to the CCTA Conference, congratulated the President on his masterly conduct of the proceedings and expressed deep appreciation of his untiring efforts towards making the Conference a success Any results achieved were due in no small measure to the President's tact and personality

He also paid a tribute to the excellent work of the Administrative and Technical Secretaries and to the entire staff of the MRC

Dr CLEMENTS, speaking on behalf of the FAO/WHO Joint Expert Committee, endorsed Dr Hawe's remarks He expressed appreciation of the opportunity given to members of the Joint Committee to participate in the technical discussion It was the first occasion that an expert committee had had the benefit of technical and expert briefing It was particularly gratifying to him personally to be associated with the CCTA in the present Conference which was the outcome of a suggestion he had taken to Professor Platt a couple of years ago, at the direction of the Director General of WHO

Professor RAOULT, on behalf of the French Delegation, wished to join in the remarks made by the previous speakers He thanked the President for the excellent facilities provided, and for his generous hospitality He referred to the valuable contacts established and expressed his admiration of the advanced scientific research being carried out under the able guidance of Professor Platt

Professor BIGWOOD proposed that a message of regret should be transmitted on behalf of the Conference to Sir Edward Mellanby who had unfortunately been prevented from attending

It was so agreed

Professor CAMBOURNAC wished to join his thanks to those of the previous speakers He likewise thanked the President for the facilities provided and for his generous hospitality

The PRESIDENT thanked all present for their kind expressions of goodwill and for their co-operation in making the Conference a success He expressed his appreciation of the work of the technical staff lent by WHO

He suggested that a message of appreciation and thanks should be sent to His Excellency Sir Percy Wyn-Harris for his continued interest and unfailing generosity, and to members of his staff for their help in the smooth running of the proceedings

This was agreed

He expressed the hope that one result of the Conference would be that African mothers would be able to pass on to their babies the heritage of good health which they should rightfully enjoy Even a measure of success in this direction would be a real contribution to human happiness and well-being and one of the best means of contributing to world peace

He declared the Second Nutrition Conference of the CCTA closed

INDEX

Italicized numbers indicate whole communications or demonstrations

ART PLATES

Figures 1 - 56



PLATE 1 UNDERWOOD GROUND

(l to r) (i) moderately severe case of kwashiorkor, having oedema and dermatosis of legs (ii) pre-kwashiorkor, showing hair changes and enlarged liver (iii) kwashiorkor after treatment (iv) 'normal' child.

CLINICAL - demonstrations

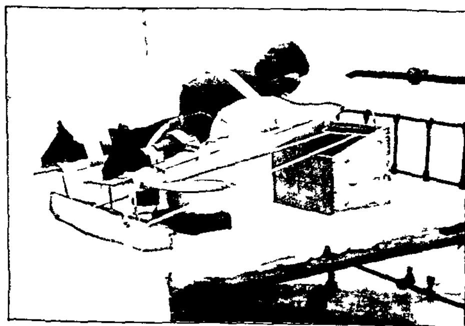


PLATE 2 PLATT

Bed for metabolic studies



PLATE 3 FRONTALI

Starchy food dystrophy localized oedema of the face, the dorsal regions of hands and feet, and the pretibial regions, the subcutaneous tissue at the thorax and the abdomen is rather dehydrated



PLATE 4 FRONTALI

Universal oedema, hyperpigmentation of the dorsal regions of the hands



PLATE 5 FRONTALI

Oedema and pellagroid hyperkeratosis of the hands



PLATE 6 FRONTALI

Starchy food dystrophy in the dry form (after elimination of oedema), hyper- rather than hypo-pigmentation



PLATE 7 FRONTALI

Bullous pellagra manifestations associated with starchy food dystrophy



PLATE 8 FRONTALI

The same, regressed after nicotinamide treatment without other changes in the diet



PLATE 9 FRONTALI
Starchy food dystrophy associated with beriberi polyneuritis

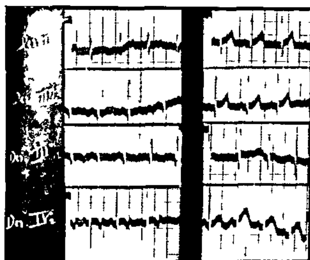


PLATE 10 FRONTALI
Electrocardiographic alterations - patient shown in plate 9 Note T-wave on the left (before) and on the right (24 hours after beginning treatment with thiamine)



PLATE 11 FRONTALI
Starchy food dystrophy with rarefied, silky, brittle hair and with some depigmented tufts Perioral signs of ariboflavinosis



PLATE 12 FRONTALI
Lower limbs of patient in plate 11 showing oedema and dyspigmentation of skin of the thighs in the 'mosaic' pattern



PLATE 13 FRONTALI

Fatty infiltration of the liver in starchy food dystrophy (Sudan III)

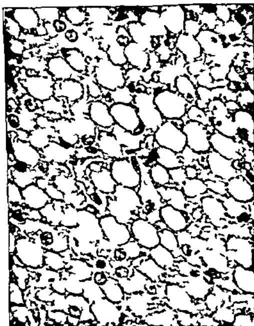


PLATE 14 FRONTALI

The same as plate 13, showing intracellular vacuoles with eccentric nuclei



PLATE 15 FRONTALI

Pancreas in starchy food dystrophy· interstitial oedema, no fibrosis

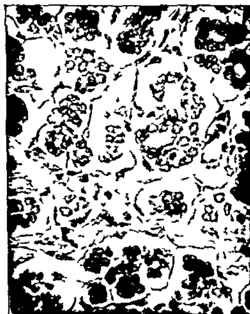
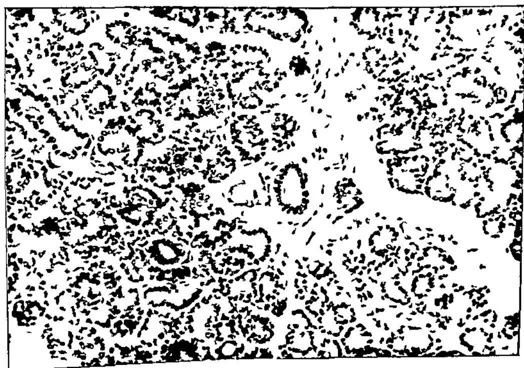


PLATE 16 FRONTALI

The same as plate 15 marked diminution of zymogen granules.

PLATE 17 DAVIES

Kwashiorkor Pancreas, showing acinar cell atrophy and fine fibrosis, no ductal changes (x 210)



DAVIES

PLATE 18
Kwashiorkor Lachrymal gland, showing moderate atrophy (x 210)

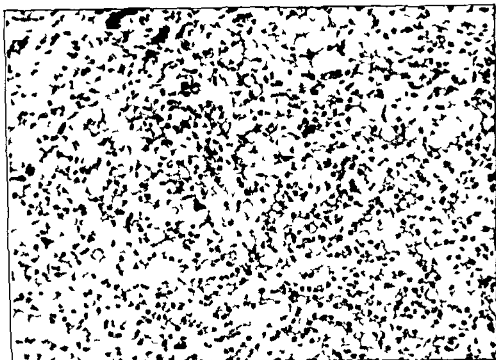


PLATE 19 DAVIES

Kwashiorkor - early case Liver, showing moderate early fat infiltration, maximal at the periphery of the liver lobule and decreasing towards the central vein Malaria pigment in the portal tract with no stellate fibrosis (x 210)

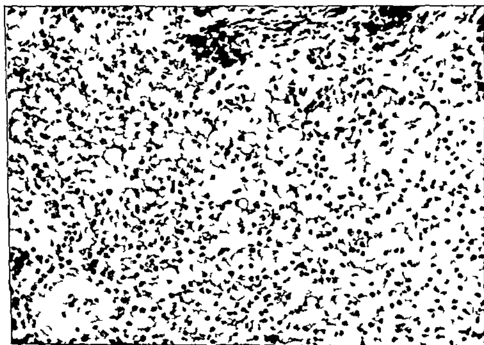


PLATE 20 DAVIES

Kwashiorkor - late case Liver, showing peripheral fat accumulation with increased cellularity and fibrosis and malarious pigmentation of the portal tract Some of the peripheral cells are free of fat (x 210)



PLATE 21 BERTE

Shows the extremely fragile, spongy, poorly staining, character of the dermis The epidermal covering is frequently missing and there is a cellular dermal infiltrate The infiltrate forms perivascular cuffs but elsewhere is scattered evenly throughout the field

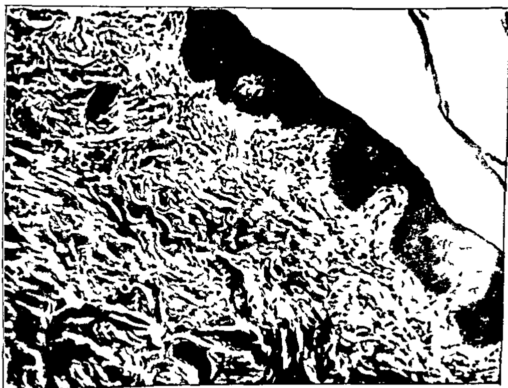


PLATE 22 BERTE

Shows intercellular clefts in the deep layer of the dermis



PLATE 23a BERTE



PLATE 23b BERTE

Show areolar pattern of the papillary layer of the dermis, clear perivascular spaces and vascular dilatation, stagnation of blood flow and hypertrophy of the endothelium



PLATE 24 BERTE

Shows dry lesion with (i) at the level of the dermis, fenestrated appearance of the deep layer of the dermis, perivascular arrangement of the infiltrate and enlargement of the dermal papillae with the outline of the dome-shaped depression at the top (ii) at the level of the epidermis, irregularity of epidermal thickness interruption of the granular layer, absence of the horny layer and epidermal oedema.



PLATE 25 BERTE

Shows weeping and exfoliating lesions with (i) at the level of the basal layer, areas of cell division with numerous mitoses, (ii) at the level of the Malpighian layer, intracellular oedema, cells lying free in the intercellular spaces, and extracellular oedema splitting off the more superficial layers, (iii) at the level of the most superficial epidermal layers, parakeratosis with exfoliation and small pools of fluid being carried off in the spaces between the scales



PLATE 26 BERTE

Shows chronic weeping lesion with intracellular oedema, disorganization of the basal layer (at the two ends of the photomicrograph) and absence of granular and horny layers



PLATE 27 BERTE

Shows normal hair bulbs associated with atrophic changes in the epidermis

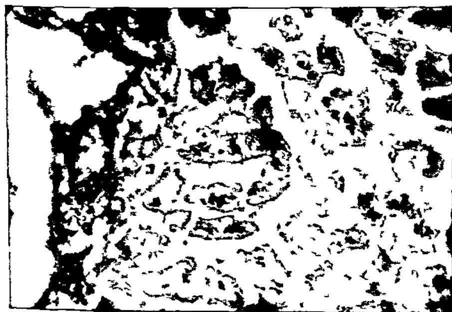


PLATE 28 EDINGTON

Type II liver- the iron pigment is mainly in the periportal parenchymal cells, there is very little in the Kupffer cells and none in the portal tracts (x 750) Section stained by Perl's method.



PLATE 29 EDINGTON
Type III liver there is much iron pigment in the parenchymal cells, Kupffer cells and portal tracts (x 750) Section stained by Perl's method



PLATE 30 EDINGTON
Type IV liver the liver is cirrhotic and the iron pigment is distributed as in type III (x 750) Section stained by Perl's method

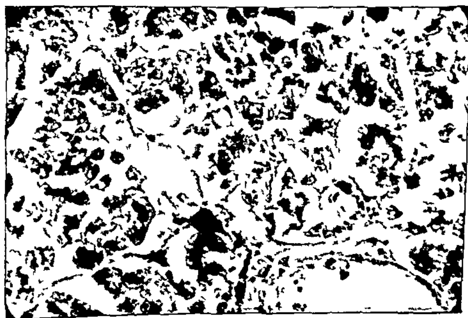


PLATE 31 EDINGTON
Iron pigment in the pancreas (x 750) Section stained by Perl's method



PLATE 32 BALFOUR

Formalin fixed frozen section (x 1800) of rat liver stained with Regaud's haemotoxylin The animal was fed on sorghum diet from weaning and was killed at 62 days of life The section shows mitochondria confined to the periphery of the cell and the region of the nucleus An amorphous substance which is probably glycogen occupies a considerable part of the intervening cytoplasm



PLATE 33 BALFOUR

Zenker-formol fixed paraffin section (x 1800) of rat liver stained with haemotoxylin and eosin The animal was fed on sorghum diet from weaning and was killed at 62 days of life The section shows the empty or rimmed appearance of the cytoplasm and the small dense nuclei containing large nucleoli, characteristic of the liver cells of animals fed on low protein diet



PLATE 29 EDINGTON

Type III liver- there is much iron pigment in the parenchymal cells, Kupffer cells and portal tracts (x 750) Section stained by Perl's method

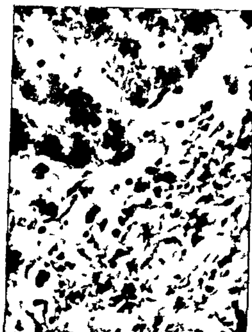


PLATE 30 EDINGTON

Type IV liver- the liver is cirrhotic and the iron pigment is distributed as in type III (x 750) Section stained by Perl's method

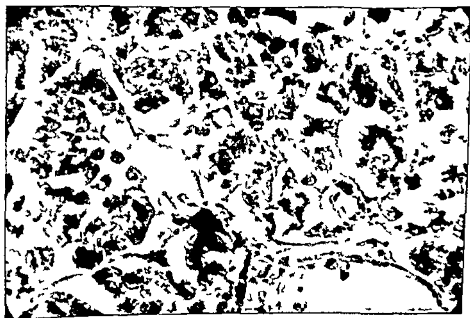


PLATE 31 EDINGTON

Iron pigment in the pancreas (x 750) Section stained by Perl's method

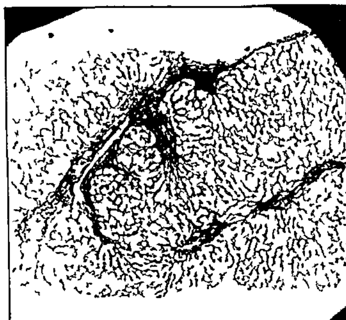


PLATE 36 WALTERS & WATERLOW

A localized coarse periportal fibrosis in section of liver (x 90) from child aged 3½ years with enlargement of liver and spleen

PLATE 37 WALTERS & WATERLOW

Liver section (x 300) from infant aged 14 months with malnutrition and malaria, showing 'untidy' outgrowth of reticulin fibres from portal tract into parenchyma - small groups of cells are surrounded.

(11926)

PLATE 34 BALFOUR

Zenker-formol fixed paraffin section (x 1800) of rat liver stained with haemotoxylin and eosin The animal was fed on sorghum diet from weaning until 48 days of life, when it was given a supplement of 0 85% lysine for 14 days and then killed The section shows the unusually dense cytoplasm but more normal appearance of the nuclei of the liver cells





PLATE 35 BALFOUR

Zenker-formol fixed paraffin section (x 1800) of rat liver stained with haemotoxylin and eosin The animal was fed on sorghum diet from weaning until 48 days of life when it was given a supplement of the B-complex of vitamins and inositol and choline for 14 days and then killed The section shows that the liver cells have more cytoplasm compared with the cells in plate 33 their appearance is not normal The nuclei are small but less dense than those in plate 33



PLATE 40 SILVERA

Section of liver (x 225) showing extreme fatty change with necrosis of odd cells, changes are generalized, architecture distorted, portal tracts normal Taken from male child aged 10 days, with ophthalmia neonatorum but otherwise a normal baby Liver not palpable (Case 12)

PLATE 41 SILVERA

Section of liver (x 225) showing extreme generalized fatty change, portal tracts normal Taken from male infant aged 12 days Normal baby except for thrush (Case 13)

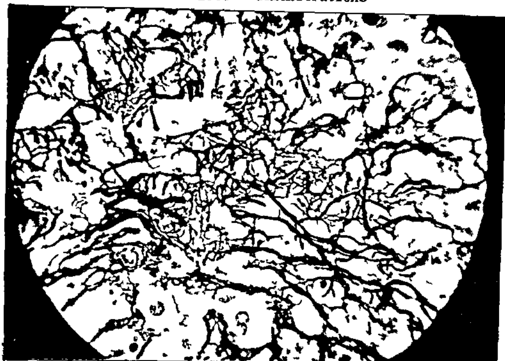


PLATE 38 WALTERS & WATERLOW

Detail of lesion of liver at edge of portal tract showing disorganization and outgrowth of fibres (x 800) - from infant aged 2 years with oedema, no increase of fat in liver



PLATE 39 WALTERS & WATERLOW

Severe diffuse fibrosis of liver of child aged 10 years with oedema and ascites



PLATE 44 MAEGRAITH

Centrilobular changes in falciparum malaria (x 50)

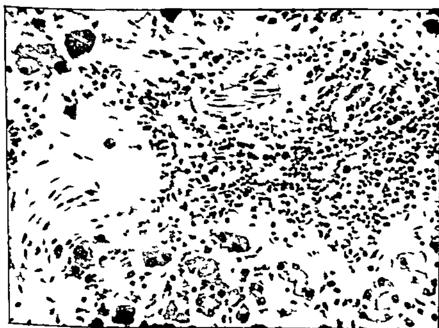


PLATE 45 MAEGRAITH

Round cell infiltration of Elisson's capsule in long-standing falciparum malaria.

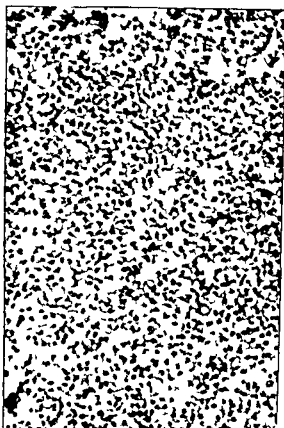


PLATE 42 SILVERA

Liver section (x 225) from male stillborn infant (delivered after prolonged labour) showing dilatation and engorgement of central veins and sinusoids, with fatty change in cells situated centrilobularly (Case 4)

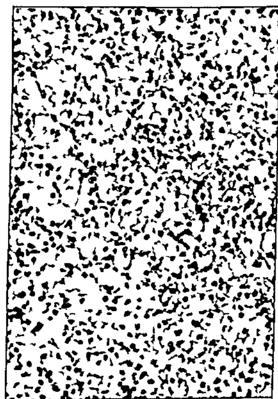


PLATE 43 SILVERA

Section of liver (x 225) showing generalized fatty change sinusoids and portal tracts normal Taken from premature female infant (3 lb 10 oz), there was blue asphyxia. She died suddenly on second day Liver not palpable (Case 5)



PLATE 50 CAMAIN & PIERCHON

Atrophy of exocrine tissue, with fibrosis and considerable canalization



PLATE 51 CAMAIN & PIERCHON

Atrophy of exocrine tissue, fibrosis gross hypertrophy of endocrine tissue

BIOCHEMISTRY - demonstrations

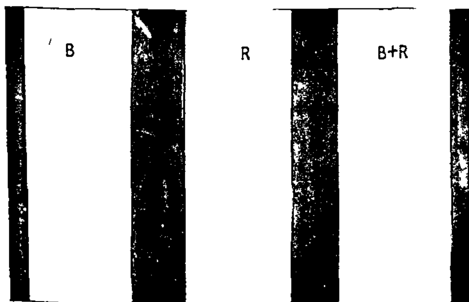


PLATE 52 NAGCHAUDHURI & PLATT

Shows behaviour on chromatography of extracts from (B) black hair of normal African and (R) red hair of African suffering from protein malnutrition (see text for details)

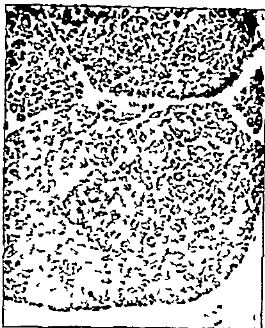


PLATE 46 CAMAIN & PIERCHON

Hypotrophy of the exocrine tissue of the pancreas, no fibrosis, *no hypertrophy* of the endocrine tissue



PLATE 47 CAMAIN & PIERCHON

Hypotrophy of exocrine tissue of pancreas, no fibrosis but showing *hypertrophy* of endocrine tissue

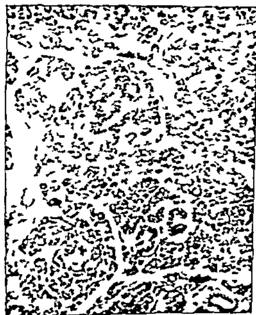


PLATE 48 CAMAIN & PIERCHON

Atrophy of exocrine cells slight fibrosis and hypertrophy of endocrine cells



PLATE 49 CAMAIN & PIERCHON

Atrophy of exocrine tissue, with fibrosis and incipient canalization



PLATE 53 JELLIFFE
'Dada' in smaller twin, age one month



PLATE 54 JELLIFFE
'Dada' in three year old boy



PLATE 55 JELLIFFE
Kwashiorkor and infective gangrene of the mouth in a three year old Yoruba boy



PLATE 56 JELLIFFE
Kwashiorkor and infective gangrene of the mouth after six weeks' treatment